

#	Ch	From Page	From Line	To Page	To Line	Comment
1	3	0	0	0	0	Along with Thermal and Hydropower Plants, should Nuclear Power Plants be discussed for water consumption. How about processing and manufacturing industries. (Ambulkar, Archis, Brinjac Engineering Inc.)
2	3	0	0	0	0	General comment - Chapter 3:\nPlease check formatting/consistency - e.g. Pg 8 Lines 26-27. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
3	3	0	0	0	0	General comment - Executive Summary:\nThere are a number of points on the science but only two on adaptation. There is some very good information in Sections 3.6 and 3.7 that needs to be included in the Executive Summary as these would provide guidance for decision makers on how to address climate change related issues.\nSynergies/conflicts between adaptation and mitigation efforts need to be highlighted to maximise effectiveness and prevent maladaptation. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
4	3	0	0	0	0	This chapter has improved compared to FOD. In terms of overall presentation styles, now Chapter 3 is in line with other chapters e.g. Chapter 26. Also, role of internal climate variability is recognized in the SOD. There are still some major issues those, I think, should be addressed. Two specific major issues are: (1) land use change as non-climatic drivers (Figure 3-1, and several places in the chapter 3 e.g. Page 4, Line 42): There are a number of studies which have shown significant hydro-climatic impacts of land use/land cover change through land-atmosphere feedback mechanisms e.g. positive soil moisture and precipitation feedback mechanism, surface albedo feedback mechanism, and changes in Bowen Ratio (ratio of sensible to latent heat flux). There are also studies, based on observations, which have documented climate impacts of land use change. Below I provide only few selected recent publication's references: ***** continued (1 of 6) (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
5	3	0	0	0	0	(1) Avila, F. B., A. J. Pitman, M. G. Donat, L. V. Alexander, and G. Abramowitz (2012), Climate model simulated changes in temperature extremes due to land cover change, J. Geophys. Res., 117, D04108, doi:10.1029/2011JD016382.\n(2) Fall, S., D. Niyogi, A. Gluhovsky, R. A. Pielke Sr., E. Kalnay, and G. Rochon (2010), Impacts of land use land cover on temperature trends over the continental United States: assessment using the North American Regional Reanalysis, Int. J. Climatol., 30, 1980–1993, DOI: 10.1002/joc.1996.\n(3) Kumar S., P. A. Dirmeyer, V. Merwade, T. DelSole, J. M. Adams, and D. Niyogi, 2013(d): Land Use/Cover Change Impacts in CMIP5 Climate Simulations –A New Methodology and 21st Century Challenges. Journal of Geophysical Research (Atmospheres), doi:10.1002/jgrd.50463, in press.\n(4) Kumar, S., V. Merwade, W. Lee, L. Zhao, and C. Song (2010), Hydroclimatological impact of century long drainage in midwestern United States: CCSM sensitivity experiments, J. Geophys. Res., 115, D14105, doi:10.1029/2009JD013228.\n(5) Lawrence et al. (2012), Simulating the Biogeochemical and Biogeophysical Impacts of Transient Land Cover Change and Wood Harvest in the Community Climate System Model (CCSM4) from 1850 to 2100, J. Clim., 25, 3071–3095. DOI: 10.1175/JCLI-D-11-00256.1 *****continued (2 of 6) (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
6	3	0	0	0	0	(6) Loarie, S. R., D. B. Lobell, G. P. Asner, Q. Mu and C. B. Field (2011), Direct impacts on local climate of sugar-cane expansion in Brazil, Nature Climate Change, 1, 105-109, doi:10.1038/nclimate1067.\n(7) Noblet-Ducoudre et al. (2012), Determining Robust Impacts of Land-Use-Induced Land Cover Changes on Surface Climate over North America and Eurasia: Results from the First Set of LUCID Experiments, J. Clim., 25, 3261–3281. DOI: 10.1175/JCLI-D-11-00338.1.\n(8) Pielke, R. A., Sr. (2011), Land use/land cover changes and climate: modeling analysis and observational evidence, WIREs Climate Change, 2, 828-850, doi: 10.1002/wcc.144. ***** continued (3 of 6) (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)

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7	3	0	0	0	0	Authors can find many more references in the above-referred papers. In view of above evidences: I urge the authors to reconsider their representation of land use/land cover change as non-climatic drivers. \nI also understand author's viewpoints. One idea could be to make a special class which has both climatic as well as non-climatic influences and include land use /land cover in this special class. -***** continued (4 of 6) (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
8	3	0	0	0	0	In order to reflect contributions made by developing countries in the aspect of climate change adaption, it is suggested to increase the adaptive policymaking and measures of fresh water resources incorporated in "The Second National Assessment of Climate Change which was adopted as the formal reference literature (Duan, Juqi, National Climate Center, Chinese Meteorological Administration)
9	3	0	0	0	0	First, this chapter assesses climate change impacts on freshwater resources by citing many research literatures, but the literatures cited cannot definitely prove that the changes happened or the impacts suffered in freshwater resources can be directly attributed to climate change. The attribution issue also exists in chapter 4. Therefore, I suggest IPCC should further emphasizes the importance of taking further studies on attribution of changes in freshwater resources and terrestrial ecosystems, identifying the percentage of climate change in the attribution of the changes in freshwater and ecosystems. Second, the literatures cited are not in balance, with more literatures cited coming from developed country, but less from developing countries. The study outcomes from different regions and the academic views have not been adequately and evenly reflected. A few viewpoints expressed in chapter 3 have not adequately reflected the status and progress of relevant scientific studies. In the revisions followed, these aspects should be effectively addressed. (wang, chunfeng, State Forestry Administration, China)
10	3	0	0	0	0	I wish to thank the authors and the review editors for considering my comments on the first draft and addressing some of them. Not all of my review comments were addressed, neither those addressed were made in a perfect way, but this is understandable as the authors's views apparently are different from mine. But I am generally satisfied that my comments were considered.\n(Koutsoyiannis, Demetris, National Technical University of Athens)
11	3	0	0	0	0	[This comment does not refer to the substance of the chapter but to the IPCC procedures]\nI found it very disturbing that the Second-Order Draft files do not allow any use of reviewing/annotating tools on the pdf. Comments on the pdf were not allowed also in the first draft, but at least the latter allowed copy and paste, which enabled some indirect use of reviewing tools. The Second-Order Draft has disabled even copy-paste, so if a reviewer wishes to refer to a phrase in the Draft, he must retype it. Certainly, this discourages reviewing more than in the first draft. I hope that in any next phase these restrictions be removed so that a reviewer can insert his comments in his personal draft when reading it, before he organizes them in Excel format.\n\n(Note: The comment that is mentioned in this review for Chapter 3 is pasted above, and added to the General Comments for the report.)\nI see that the Second-Order Draft may contain substantial changes at points. However, given the above caveat/discouragement, I decided not to review the entire document but to check it with respect to addressing my review comments on the earlier draft. In particular, based on my earlier review report, I will only suggest a few additions, which I regard very important.\n (Koutsoyiannis, Demetris, National Technical University of Athens)
12	3	0	0	0	0	Cross-reading with chapters 4,5, 23 and 28 would be good (Rankinen, Katri, Finnish Environment Institute)
13	3	0	0	0	0	It would be very useful for the reviewer to see the figures and tables of the report at the point of citation. The figures and the tables are presented at the end of draft report.(Athanasios Loukas, Civil Engineering Department, University of Thessaly, Greece) (GREECE)
14	3	0	0	0	0	General comment: Note that there is an inconsistency in the chapter referencing the SREX report by 'author' or 'IPCC'. Please be consistent. (AUSTRALIA)

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15	3	0	0	0	0	General comment: Long sentences make the chapter hard to read. Suggest trying to keep sentences short, as long sentences at times make the meaning difficult to interpret. (AUSTRALIA)
16	3	0	0	0	0	General comment: This chapter could benefit from some discussion on El Niño Southern Oscillation (ENSO), La Niña and other climate drivers that have an impact on water resources. (AUSTRALIA)
17	3	0	0	0	0	There is a missing clarity in the terminology, because certain comments mix up global and regional scale. This becomes obvious when talking about river-discharges, it is well-known that for certain rivers the situation can be very different. This can be measured only at a certain gauge (local). When discussing about global discharges one would expect catchment assessments, but in Fig. 3-7 the reader see only general changes. Is it possibly the surface run-off, or really river discharge. In the latter case I would suggest to change the figure. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
18	3	0	0	0	0	The SOD of Chapter 3 is well done incorporating many latest research results and some 2013 published papers, they expand reader's perspective and scientific insights in the field of impact of climate change on freshwater resources and adaptation as well. Congratulations to all CLA and LA. It needs to finalize some figures and text in final report. (Chunzhen, Liu, Ministry of Water Resources)
19	3	0	0	0	0	Regarding glacier melt impact to downstream flow, IPCC 2007 report made high confidence statements such as "as these glaciers retreat due to global warming, river flows are increased in the short term, but the contribution of glacier melt will gradually decrease over the next few decades"(Chapter: Freshwater PP 184) and "the enhanced melting of glaciers leads at first to increased river runoff and discharge peaks and an increased melt season" (IPCC, 2007). These statements mirror the point of view expressed in the IPCC 2001 report as well. These statements have had huge impact on policy formulations and overall understanding of the society regarding the impact of glacier melt, especially in the South Asian region. (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
20	3	0	0	0	0	It is welcome that the IPCC 2007 statements mentioned above in the section-A are not repeated in the present draft. However no justification is provided for the present shift in such a high confidence statements of the previous assessment. (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
21	3	0	0	0	0	Thayyen, R. J. and Gergan, J. T. (2010) Role of glaciers in watershed hydrology: a preliminary study of a "Himalayan catchment", The Cryosphere, 4, 115-128, doi:10.5194/tc-4-115-2010, 2010: (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
22	3	0	0	0	0	pointed ou that these statements linking glacier melt with river runoff is flawed as the downstream flows variation in response to glacier melt could vary across various glacio-hydrologic regimes. The essence of the argument is that rise in temperature will indeed result in to enhanced "glacial degraded runoff component" in the stream flow but that is not necessarily translate into increased stream discharge downstream. Contrary, it is showed that the glaciers under the monsoon regimes could produce higher catchment discharge during the period of mass gain by the glaciers. (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
23	3	0	0	0	0	Ref for " glacial degraded runoff component" UNESCO.: Variations of snow and ice in the past and at present on a global and regional scale (Ed. Kotlyakov, V.M.), IHP-IV Project H4.1, Paris,1996 (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
24	3	0	0	0	0	Suggesting low confidence in the precipitation projection (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)

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25	3	0	0	0	0	The synthesis on the freshwater resources changes in Chapter 3 of the IPCC report is generally successful and relatively complete. However, as already mentioned in my previous review, the section 3.2 on the trends from the observations and measurements is incomplete and the bibliography is incomplete. Indeed, the section of the measurements is limited to a summary of trends. However, in recent years, there are studies that have focused on methods other than the trend tests, using methods such as signal processing, such as wavelet analysis, to search modes of variability in hydrological and climate parameters in different hydrosystems in the world and thus investigate the relationships between hydrological variability and climate fluctuations. This work has highlighted the relationship between the flows variability and those of climate indices such as NAO, ENSO, PDO, but also major discontinuities in the 70s and 90s. It therefore seems important to summarize these works. Moreover, in this observations and measurements section, the authors do nothing on satellite data, such as change in sea level, but also on the variability of the global reserve of water (surface water + soil moisture + groundwater, eg GRACE data) I think a methodology section about the main methods to study the relationship between climatic parameters and hydrological variables is necessary (Laignel, Benoit, University of Rouen)
26	3	0	0	0	0	There are several interesting figures such as relative change in annual discharge (figure 3-7), flood hazard change (figure 3-8), etc. Taking into account that the figures of the SODreview version usually has not got the best resolution, we want to encourage authors to set the highest resolution to the figures of the final version in order to have some notion of these projections in small territories. for example the Canary Islands. (SPAIN)
27	3	0	0	0	0	The issue of assessing hydrological changes and identifying the impacts of climate change among other dynamics and impacts of other changes is a key one - as expressed in this second draft version. Very recent publications should be referred to, especially Koutsoyiannis, D., 2013. Hydrology and change. Hydrological Sciences Journal, in press, DOI: 10.1080/02626667.2013.804626 - available in early view at http://www.tandfonline.com/doi/abs/10.1080/02626667.2013.804626#.UZ80XUqyo9M . Further, one emerging key reference is addressing this particular issue in terms of formulating the scientific questions and setting the scientific agenda from the hydrological community through the launching of the new decade called 'Panta Rhei' of the IAHS - International Association of Hydrological Sciences. See the scientific article Montanari A., Young G., Savenije H., Hughes D., Wagener T., Ren L., Koutsoyiannis D., Cudennec C., Grimaldi S., Blöschl G., Sivapalan M., Beven K., Gupta H., Arheimer B., Huang Y., Schumann A., Post D., Taniguchi M., Boegh E., Hubert P., Harman C., Thompson S., Rogger M., Hipsey M., Toth E., Viglione A., Di Baldassarre G., Schaeffli B., McMillan H., Schymanski S., Characklis G., Yu B., Pang Z., Belyaev V. "Panta Rhei – Everything Flows": Change in hydrology and society – The IAHS Scientific Decade 2013-2022. Hydrological Sciences Journal, in press, very soon available at http://www.tandfonline.com/toc/thjs20/current#.UZ9MQEqyo9M (Cudennec, Christophe, Agrocampus Ovest)
28	3	0	0	0	0	This chapter is very comprehensive and generally well-written. I don't see any gaps in the writing other than those already flagged by the authors. (Macinnis-Ng, Cate, University of Auckland)
29	3	0	0	0	0	The authors should establish a clear bar (consistent across the chapters) for what is included in each executive summary. It would strengthen the summaries to only include summary statements where there is "high agreement" supported by "robust evidence." We recommend that the authors not include statements supported by limited evidence in summaries. (UNITED STATES OF AMERICA)

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30	3	0	0	0	0	With regard to the use of qualifying terms (E.g., high confidence, high agreement, robust evidence, etc), we recommend the following:\n¥ Each of the terms used should be defined in a box within the chapter and should be consistent with their usage throughout the document.\n¥ The terms should be applied consistently and should be independent. I.e., the statement on page 2 line 43 has three qualifying terms but the statement on page 2 line 49 has two. The term "high confidence" is redundant and a dependent on "agreement" and "evidence." \n¥ The context and linkage between these qualifiers should be consistent with their definitions. E.g., page 9 line 41 "low confidence with limited evidence" versus page 9 line 49 "low confidence due to limited evidence." The former suggests these are independent variables; the latter suggests they are dependent. Another example of inconsistent usage is on page 3 line 1 where there is "high confidence" dispute the fact that there is "limited evidence." This suggests a bias towards over-confidence not supported by evidence. \n \n (UNITED STATES OF AMERICA)
31	3	0	0	0	0	The chapter uses alternatively the terms "climate change" and "anthropogenic climate change". I doubt that when the second is used the authors can really make a precise reference to the anthropogenic sources. In case they are used as synonymous , I'd disagree, because that would mean that CC is only of anthropogenic origin (ITALY)
32	3	0	0	0	0	The second-order draft of the IPCC WGH AR5 Chapter 3 “Freshwater Resources” includes:\nA. Executive summary of about 1.5 page;\nB. Main body of the report divided into 8 sections: (1) Introduction, (2) Observed hydrological impacts of CC, (3) Drivers of change for freshwater resources, (4) Projected hydrological changes, (5) Impacts, vulnerabilities and risks, (6) Adaptation and managing risks, (7) Linkages with other sectors and services, and (8) Research and data gaps. of about 30 pages, illustrated by about 16 pages of figures and tables.\nC. Frequently Asked Questions of about 1.5 page;\nD. Cross-Chapter Boxes (CC-RF, CC-VW, CC-WE) on three issues of particular importance for CC: (1) Impact of CC on freshwater ecosystems due to altered river flow regimes, (2) Active role of vegetation in altering water flows under CC, and (3) The Water-Energy-Food nexus as linked to CC, of about 7.5 pages (text and literature) and 4 figures RF-1, RF-2, VW-1 and WE-1.\nE. Literature – 21 pages (42 to 63)\nOne of the principal question concerning chapter 3 of AR5 is how much this assessment has changed since publication of a similar part of AR4, it means chapter 3 “Freshwater resources and their management” published in 2007. Although in Chapter 3 under review the AR4 is mentioned in some sections, but it’s not easy at all to judge how much the situation has changed in the last 5 years and what’s new. It is suggested that in the future each chapter of AR (including of course the one concerning freshwater resources) ends with a brief evaluation how much the situation has changed since the last assessment and what’s new, what are the new approaches, methods and other guidance. (POLAND)
33	3	0	0	0	0	The next general comment concerning Chapter 3 concerns the Executive Summaries. Some of them in the present draft of Chapter 3 are pretty obvious and well known, like for example the one about the glaciers – this is something what the school children know. But here are others which say that depending on the circumstances “..the operating costs will rise or fall”, or “... certain approaches ... imply greater risks ... than others”. The people to whom we address the executive summaries usually know well that all depends on the context. In addition, compare executive summaries of chapters 3 in AR5 and AR4 – they have nothing in common. (POLAND)
34	3	0	0	0	0	To summarize, on the whole Chapter 3 in AR5 is certainly much more informative than the corresponding chapter in AR4. I suggest to keep in principle the same table of contents in the next editions of the AR. The cross-chapter boxes is a good idea and in a way similar are case studies (3.6.6). (POLAND)
35	3	0	0	0	0	All coordinating lead, lead and contributing Authors should be congratulated on the work well done. (POLAND)
36	3	0	0	0	0	didn't see a good place to put in the reference, but in a number of countries there has been work on the iinteraction of extreme drought and flood protection levies -- the NL is very worried about this, since their earthen dams tend to become much more likely to fail during droughts as a result of floods. (Matthews, John, Conservation International)

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37	3	0	0	0	0	Water diversions are almost completely ignored in this chapter but already represent a major investment strategy by many countries. China's South-North project, for instance, is more than biblical in its scope. And this is not the only large project either planned or already underway by China. India too has had massive plans for moving water to drier regions on maps that make almost no hydrological sense. Even in the US, there are regular, credible calls for moving Mississippi River water >1000 km to Nevada, or to preserve large cities such as Dallas and Los Angeles at the expense of ecosystems and more rural and small town livelihoods and economies as a result of water diversions almost as large in scope. These are highly political issues to be sure, but they are also very important ones. (Matthews, John, Conservation International)
38	3	0	0	0	0	I think this chapter needs significant more work. The use of literature is highly selective and it is not clear how the authors have chosen particular references as not detail is given on how they searched the literature and what caveats and limitations should be applied. The chapter is particularly weak on water and sanitation services and does not refer to existing literature that tries to address these issues. The sections dealing with groundwater also need further editing to reflect more recent evidence and sections on hydropower need better balance as they routinely fail to address run of the river schemes and only focus on hydropower with associated storage. Generally coverage of developing countries is weak. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
39	3	0	0	0	0	Table 3.3: this includes only two studies from Uganda focused on north and east but ignores, for instance, Howard et al 2003 (Water Research vol 37) on the impact of rainfall on shallow groundwater in urban areas of that country. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
40	3	0	0	0	0	There are some missing/ incorrect citations in the chapter. These discrepancies have been highlighted in the ref check document for chapter 3 and is available in the supporting material web page. Chapter team may wish to rectify these errors before starting to work on SOD revisions and FGD preparation. (Chatterjee, Monalisa, IPCC WGII TSU)
41	3	0	0	0	0	1) Overall -- The chapter team has developed a strong 2nd-order draft. In the final draft, the chapter team is encouraged to continue prioritizing compact and rigorous assessment, effective figures, clear writing, and high specificity. (Mach, Katharine, IPCC WGII TSU)
42	3	0	0	0	0	2) Coordination across Working Group II -- In developing the final draft of the chapter, the chapter team should continue to ensure coordinated assessment, both in the chapter text and at the level of key findings. As appropriate, cross-references to the sections of other chapters and/or their assessment findings should be used, continuing to ensure that overlaps are reduced and assessment harmonized. (Mach, Katharine, IPCC WGII TSU)
43	3	0	0	0	0	3) Harmonization with the Working Group I contribution to the AR5 -- Given the climate/impacts handoffs particularly relevant in the context of chapter 3, the chapter team should ensure all cross-references to the Working Group I contribution are updated, with assessment in this chapter harmonized with the findings of the Working Group I contribution. Where chapter 3 cross-references findings from a special report on extremes, the author team should also consider the key findings of the Working Group I contribution to the 5th assessment report. Especially for conclusions highlighted in the executive summary of the chapter, clear interpretation with respect to findings on similar topics within the Working Group I contribution should be ensured. (Mach, Katharine, IPCC WGII TSU)

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44	3	0	0	0	0	4) Calibrated uncertainty language: likelihood terms versus levels of confidence -- In some sections of the chapter text, levels of confidence may be preferable to likelihood terms currently used. The chapter team is encouraged to ensure that all likelihood terms used are supported by its assessment of available probabilistic information in the corresponding literature. If such a probabilistic basis is not available, presenting a level of confidence would be preferable. In such cases, summary terms for evidence and agreement also could be presented. Throughout, casual usage of the reserved likelihood terms should be avoided wherever possible, and all calibrated uncertainty language (summary terms for evidence and agreement, levels of confidence, and likelihood terms) should be italicized. (Mach, Katharine, IPCC WGII TSU)
45	3	0	0	0	0	5) Report release -- The chapter team should be aware that the final drafts of the chapters will be posted publicly at the time of the SPM approval, before final copyediting has occurred. Thus, the chapter team is encouraged to continue its careful attention to <u>refined syntax and perfected referencing</u> . (Mach, Katharine, IPCC WGII TSU)
46	3	0	0	0	0	6) Tightening the assessment and supporting a maximally rigorous executive summary -- In developing the final draft, the chapter team is encouraged to revise each section so that the core nuanced key findings emerge clearly from each section with full and traceable support. Revision geared towards highlighting the key findings will further support an executive summary that richly communicates the assessment. The chapter team should prioritize revision as well within sections that could benefit from further strengthening, such as in some parts of 3.5 and 3.6. (Mach, Katharine, IPCC WGII TSU)
47	3	0	0	0	0	7) Characterization of future risks -- In characterizing future risks for freshwater resources, to the degree appropriate the chapter team should indicate the extent to which risks (or key risks) can be reduced through mitigation, adaptation, or other responses. That is, is it possible to indicate how risks may increase as the level of climate change increases or, potentially, to indicate the relative importance of changes in mean conditions, as compared to changes in extreme events, as compared to potential non-linear changes associated with biome shifts or tipping points? And then, how much can risks be reduced through adaptation or development, in the near-term and the long-term? How are factors or stressors that multiply risks relevant in this context? As supported by its assessment of the literature, the author team should consider communicating risks for the era of climate responsibility (the next few decades, for which projected temperatures do not vary substantially across socio-economic/climate scenarios) and for the era of climate options (the 2nd half of the 21st century and beyond). As might be helpful to the chapter, the framing of table SPM.4 could be considered in characterizing future risks, along with the key and emergent risk typology of chapter 19. (Mach, Katharine, IPCC WGII TSU)
48	3	0	0	0	0	8) Informing the summary products -- To support robust and insightful summary products for the report, the chapter team is encouraged to maximize nuance and traceability in its key findings, continuing to use calibrated uncertainty language. In addition to highlighting key findings throughout the chapter and characterizing future risks (see the previous comments), the chapter team is encouraged to consider themes emerging across chapters, indicating for example how extreme events have demonstrated adaptation deficits and vulnerability to date and may relate to future risks, how limits to adaptation may be relevant in the context of this chapter, how adaptation experience has been relevant to date, and how interactions among mitigation, adaptation, and sustainable development may occur. (Mach, Katharine, IPCC WGII TSU)
49	3	0	0	0	0	GENERAL COMMENTS: I congratulate the author team for their work on an interesting and informative SOD. Please see my detailed comments for suggestions related to specificity of ES findings, traceable accounts, and specific clarifications. In addition, where likelihood terms are used ("likely," "very likely," etc.), it is also not always clear whether they are intended as calibrated language or not--please carefully check this and avoid casual usage. (Mastrandrea, Michael, IPCC WGII TSU)

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50	3	0	0	0	0	SUMMARY PRODUCTS: In preparing the final draft of your chapter and particularly your executive summary, please consider the ways in which your chapter material has been incorporated into the draft SPM and TS. For Chapter 3, this includes presentation of observed impacts and vulnerabilities in section A.i and sectoral and regional risks in section C.i, as well as related figures and tables. Are there opportunities for presenting chapter findings and material in a way that further supports broad themes highlighted in the summary products and that facilitates additional cross-chapter synthesis in specific findings or figures/tables? Do the existing summary product drafts suggest additional coordination that should occur between Chapter 3 and other chapters at LAM4? (Mastrandrea, Michael, IPCC WGII TSU)
51	3	0	0	0	0	Based too heavily on "projections" which are not happening. There has been no warming for 15 years. A failure to accept that water supplies are dependent on expenditure on reservoirs, dams and supply pipes. Most of the water that arrives from the heavens drains into the sea and an improved supply depends on trapping more of it. (Gray, Vincent, Climate Consultant)
52	3	0	35	0	35	coupled (ITALY)
53	3	1	1	0	0	There is some very good information in Sections 3.6 and 3.7 that needs to be included in the Executive Summary as these would provide guidance for decision makers on how to address climate change related issues. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
54	3	1	1	0	0	Potential synergies/conflicts between adaptation options and also between adaptation and mitigation efforts need to be highlighted to maximise effectiveness and prevent maladaptation. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
55	3	1	42	1	50	Section 3.4, like "Glaciers" and "Ground Water", Subheading "Precipitation" need to be added and discussed the projected changes in precipitation and their impacts on stream flows as explained under projected hydrological changes started from page # 12 (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
56	3	1	52	2	5	Section 3.5, the impact of climate change on potable water and related health risks in particular, water bone diseases may be discussed under separate subheading (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
57	3	2	41	0	0	Characterizing Future Risks In the Executive Summary-- As much as possible, the chapter team should specify the degree to which future risks change or increase with increasing levels of climate change. Which risks emerge in the near-term, and which emerge in the long-term? What is the potential for reducing risks through adaptation and mitigation? The chapter team should also consider options for providing more quantitative information on the ranges of possible outcomes, potentially indicating differing levels of confidence for statements about overall directions of change as compared to the specific quantitative results. (Mach, Katharine, IPCC WGII TSU)
58	3	2	41	0	0	Executive Summary: Please work to refine the detail and clarity of the executive summary as you revise the chapter--I have made various specific suggestions along these lines below. For example, to the extent possible as supported by the literature, please also emphasize what risks are projected to emerge over different time horizons (e.g., mid-century vs. end-of-century), as well as the potential or lack of potential for mitigation and adaptation to reduce them. In addition, please consider the usage of calibrated uncertainty language in the executive summary, as in many cases it appears that assignment of a level of confidence may be appropriate, based on agreement/evidence evaluations already made. In cases where a finding is based on quantitative evidence, likelihood should also be considered. The TSU would be happy to consult with you on this if desired. Please also continue to ensure clear line of sight to underlying chapter sections--in general this is done well at present, but I have noted places where further clarity is needed in my specific comments. (Mastrandrea, Michael, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
59	3	2	41	4	14	In general, the Executive Summary conveys more "high confidence, high agreement, robust evidence" than may be warranted given the uncertainties noted in the chapter. (UNITED STATES OF AMERICA)
60	3	2	41	4	14	When characterizing future physical impacts, the executive summary should offer a statement as to why it makes sense to have "high agreement" and/or "high confidence" about a future impact when there's "limited evidence" of past change. (UNITED STATES OF AMERICA)
61	3	2	41	4	14	ES: Several bullets are thematically linked to WGI. It will therefore be crucially important to maintain inter-working group consistency for these key findings. Very strong statement on floods (high agreement/robust evidence) is now partially based on WGI precip projections (p2149), please reconsider this link; In addition, uncertainty assessments are sometimes not consistent, e.g., high agreement/medium evidence is declared for GHG influence on transpiration, runoff and groundwater recharge (p3110); can this impact be very uncertain and locally specific then? Please consider to link the glacier bullet to the WGI assessment (p3114). (Plattner, Gian-Kasner, IPCC WGI TSU)
62	3	2	43	0	0	Since this is the beginning of the chapter, can term "global warming" be used instead of "warming" only. (Ambulkar, Archis, Brinjac Engineering Inc.)
63	3	2	43	2	43	last decades' = ? 20 -30 years? (Bunn, Stuart, Griffith University)
64	3	2	43	2	43	If appropriate, the chapter team could consider further specifying the approximate number of decades relevant here. Possible options include "since 1950," "since 1990," etc. (Mach, Katharine, IPCC WGII TSU)
65	3	2	43	2	43	Please specify the timeframe meant by the last decades. (Mastrandrea, Michael, IPCC WGII TSU)
66	3	2	43	2	45	It isn't clear whether the phrase "in regions with seasonal snow cover" refers to all of the preceding phenomena, or just the final one(s), although I think it is the former. I suggest putting that phrase earlier, right before "warming..." (Milly, Christopher, U.S. Geological Survey)
67	3	2	43	4	0	The Executive summary presents several conclusions, but a significant portion of these is based on limited evidence, despite the high agreement. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
68	3	2	43	4	0	The Executive summary does not provide any statements on the influence of the lack of data on the conclusions made in many of the analyses, despite several references in the report to this effect. I feel this is a missed opportunity and it would be important to underline the importance of observations to improve confidence in conclusions made on the impact of climate change. This is particularly so for impacts to the hydrological given the importance of considering impacts on the regional and local scale. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
69	3	2	45	2	45	Please ensure that this finding is fully supported in section 3.2.3, as the reference to chapter 26 should be removed. (Mastrandrea, Michael, IPCC WGII TSU)
70	3	2	45	2	46	Consider re-wording sentence "Where more winter precipitation falls as rain than snow, winter low flows have increased significantly" as it is difficult to interpret. (AUSTRALIA)
71	3	2	45	2	46	Does first clause mean "Where winter precipitation is more snow than rain," or does it mean "Where a trend in winter precipitation from snow toward rain is present?" I suggest re-wording to make the meaning clear. (Milly, Christopher, U.S. Geological Survey)
72	3	2	46	2	46	winter low flows have increased significantly - this is ambiguous. It could mean the flow levels have increased (in other words, they are 'less low'), or that the occurrence of low flows has increased ('more lows'). (Dankers, Rutger, Met Office Hadley Centre)
73	3	2	46	2	47	exacerbate summer low flows - is it worth adding that this has intensified competition for water during this period? (Bunn, Stuart, Griffith University)

#	Ch	From Page	From Line	To Page	To Line	Comment
74	3	2	46	2	47	Should be "Where stream flow is low in summer", not "lowest". Decreases in late-summer low-flows exist and are practically important even in hydroclimatic regions where the lowest flows of the year occur in a season other than summer. (Fleming, Sean, Meteorological Service of Canada)
75	3	2	49	2	49	There is no material presented in section 3.4.5 that supports the assessment of high agreement and robust evidence. The phrase "large changes" does not indicate whether the change will be an increase or a decrease. The supporting text in the chapter states "considerable variability in estimated impact in each catchment across the seven scenarios and also show non-linear response to increasing forcing (in the Mitano catchment). The uncertainty is largely driven by differences in projected changes in precipitation between different climate models." In section 3.4.9 the text states, "uncertainty is still large at the global and continental scales particularly about the magnitude of changes. At local scales, even the sign of the change do not necessarily agree among GCMs". Suggest changing the assessment to (low to medium agreement, limited evidence). (UNITED STATES OF AMERICA)
76	3	2	49	2	49	Please specify this finding further--what is meant by large changes and when and where are these projected to occur? (Mastrandrea, Michael, IPCC WGII TSU)
77	3	2	49	2	50	It is the same paragraph of TS p.31 lines1-4, and consequently, my comments are the same (Llasat, Maria-Carmen, University of Barcelona)
78	3	2	49	2	52	I have not read the WGI SOD, but the present text seems to imply ("limited extent") that more frequent/intense rainfall is only expected at small space and time scales. Is this the case? (Milly, Christopher, U.S. Geological Survey)
79	3	2	49	2	52	Projected climate changes imply PROJECTED large changes... would be better wording. Let us not forget that the antecedent is uncertain. (Milly, Christopher, U.S. Geological Survey)
80	3	2	49	2	52	Why is there no statement of the confidence on frequency of floods? Also I do not understand the comment on the uncertainty of large catchments because of the limited extent of extreme events. Localised flooding is an will continue to be a major issues in large as well as small catchments, so does this comment refer to floods moving down main stems? I think this paragraph needs re-wording to clarify what is meant and acknowledge the impact of localised flooding (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
81	3	2	49	3	2	The climate projections do not indicate more frequent intense rainfall events all areas of the world. Neither do the field observations. (Wurzler, Sabine, LANUV NRW)
82	3	2	49	3	2	There are not enough agreement and evidence about the increase of intense rainfall events and floods as a consequence of climatic change in all the world (as the same report tells in SPM, p.3, lines 40-41, and in other places), neither in the future. On the other hand, floods also depends on hydrological and geomorphological factors. Consequently, this paragraph should be rewritten. One possibility would be to introduce acclarations like "in some regions", and decrease the level of certainty and robustness. This is a weak point of the report, because there are some inconsistencies between different chapters and paragraphs, in relationship with the increase/decrease of floods and the degree of evidence and robustness. Please, see my comments on this, in relationship with different paragraphs, below. (Llasat, Maria-Carmen, University of Barcelona)
83	3	2	49	3	2	The support for this statement should be clarified. Line-of-sight to supporting chapter 3 section should be provided (3.4.9?). Additionally, the reference to working group 1 could be clarified in terms of the specific finding relevant here. (Mach, Katharine, IPCC WGII TSU)
84	3	2	49	3	2	Line of sight to chapter 3 sections is needed for this paragraph. It appears that sections 3.4.5, 3.4.9, and 3.5.3 include relevant information. Please also clarify the line of sight for the statement in line 52 regarding spring flood peaks. (Mastrandrea, Michael, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
85	3	2	52	2	52	In some areas, reduced snowfall will reduce spring flood peaks. But In some area such as northwest of China,spring flood is increasing and snowfall flood peaks is higher. (wang, chunfeng, State Forestry Administration, China)
86	3	2	53	2	53	I am surprised to not see Europe (especially Mediterranean region) mentioned here (Cassardo, Claudio, University of Torino)
87	3	3	2	3	2	Please add reference to the (sub)section in which these statements are mentioned/underpinned.\n\n (NETHERLANDS)
88	3	3	2	3	2	This statement is so broad as to be meaningless. The authors should be clearly about what adaptation will reduce vulnerability and whether this is the same as investing in greater resilience. They should also provide some assessment of the quality of the evidence to support this comment. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
89	3	3	2	3	2	Please expand on this point--to what extent can vulnerability be reduced and how? (Mastrandrea, Michael, IPCC WGII TSU)
90	3	3	4	3	4	Can any further information be provided on what "hydrological regimes" means? (Mach, Katharine, IPCC WGII TSU)
91	3	3	4	3	8	This point should be made earlier in the ES (Bunn, Stuart, Griffith University)
92	3	3	5	3	6	The situation for groundwater recharge is much less certain in dry regions than implied - see the recent paper by Taylor et al who suggest that in some dry areas recharge in any cases occurs in widely spaced (and up to decadal) intervals and that the more intense rainfall expected as a consequence of climate change could in fact have a positive impact on recharge in some catchments. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
93	3	3	6	3	7	As written, I think this is incorrect. When rainfall to a basin changes by X liters, runoff does not change by 1X to 3X liters. It is the percentage or relative changes that tend to obey the 1-3X rule of thumb, no the changes themselves. (Milly, Christopher, U.S. Geological Survey)
94	3	3	6	3	7	After "...greater than changes in precipitation" suggest adding "all else being equal." (Fleming, Sean, Meteorological Service of Canada)
95	3	3	6	3	7	It would be helpful to clarify what is meant by "1 to 3 times greater"--in terms of percentage change, amount of water, etc.? (Mach, Katharine, IPCC WGII TSU)
96	3	3	6	3	7	Does this ratio of changes in runoff to precipitation hold generally across timeframes and scenarios? Please clarify. (Mastrandrea, Michael, IPCC WGII TSU)
97	3	3	7	3	7	We suggest the authors replace the term "brings forward" with "results in an earlier" for greater clarity. (UNITED STATES OF AMERICA)
98	3	3	7	3	8	Page 17 associates this effect of warming with regions where increases in precipitation are sufficient to result in increased snow accumulation, rather than very cold regions. Please clarify whether these are equivalent. (Mastrandrea, Michael, IPCC WGII TSU)
99	3	3	10	3	11	Authors should explain the logic of " high agreement" if the following sentence states "This impact is very uncertain and locally specific, " or we change the assessment to (low to medium agreement, limited evidence). (UNITED STATES OF AMERICA)
100	3	3	10	3	11	This sentence seems to me to be so limited in information content as to be meaningless. Everything in the system affects everything else. The two sentences that follow are more informative. (Milly, Christopher, U.S. Geological Survey)
101	3	3	10	3	12	Please specify this finding further--how will vegetation be affected and how does this change transpiration, runoff, and groundwater recharge? (Mastrandrea, Michael, IPCC WGII TSU)
102	3	3	11	3	11	groundwater recharge should be changed into "groundwater resources(including recharge and discharge)" (Jiang, Zhongcheng, Institute of Karst Geology,CAGS)

#	Ch	From Page	From Line	To Page	To Line	Comment
103	3	3	11	3	11	Given that lines 5-6 in the previous paragraph refer to runoff and groundwater recharge, the focus of the distinct point being made here could be clarified. How do these vegetation-related changes interact with the broader projections described above? Especially since the 2nd paragraph asserts the impact is "very uncertain and locally specific" it is critical to specify more precisely what "this impact" is here. Also, how should the assertion of a "very uncertain and locally specific" impact be interpreted with respect to the bold sentence in the same paragraph, which provides high agreement and medium evidence for a broad statement? (Mach, Katharine, IPCC WGII TSU)
104	3	3	12	3	12	State-of-the-science models do include biophysical responses to atmospheric CO2 and detailed, cross-correlated climate variables, which have been studied in several of the cited papers. (UNITED STATES OF AMERICA)
105	3	3	14	0	19	The term meltwater production is very vague. What is certain is the increase in the "glacier degraded component" of meltwater (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
106	3	3	14	3	14	The phrase "eventually diminishing" implies that meltwater yields may 1st increase and then decrease, which could be clarified more explicitly. The point is made in further detail later in the paragraph, but clearer articulation in the 1st sentence could be beneficial. (Mach, Katharine, IPCC WGII TSU)
107	3	3	14	3	19	With glacier shrinking, numerous lakes have formed and many more are likely to form in the near future (cf. Linsbauer, A., Paul, F. and Haeberli, W. (2012): Modeling glacier thickness distribution and bed topography over entire mountain ranges with GlabTop: Application of a fast and robust approach. Journal of Geophysical Research 117, F03007, doi:10.1029/2011JF002313). Many presently still existing glacier landscapes of cold mountains are, in fact, transforming within decades and for long time periods to come into lake landscapes. This should also be made clear on page 9 (see next comment - pg 9, line 34). (Haeberli, Wilfried, University of Zurich)
108	3	3	14	3	25	For the findings across these paragraphs, if possible the chapter team should consider indicating how the specific risks may decrease across differing levels of climate change, in the near-term and long-term. (Mach, Katharine, IPCC WGII TSU)
109	3	3	17	3	18	The sentence, "In many regions meltwater production will increase during the next few decades but decrease thereafter" is unnecessarily simplistic and a bit misleading. Different regions are currently at different stages along this glacial runoff curve: some are in the increasing-runoff phase, whereas others are already in the decreasing-runoff phase. Overall, both situations appear equally common over the historical record. The wording of this passage should be improved. If the author wishes to follow up on this more comprehensively, a couple of very useful overview papers include Cassassa et al. (2009) and Moore et al. (2009). The full references are: (i) Casassa G and others (2009), Detection of changes in glacial run-off in alpine basins: examples from North America, the Alps, central Asia, and the Andes, Hydrological Processes, 23:31-41; and (ii) Moore RD and others (2009), Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality, Hydrological Processes, 23:42-61. (Fleming, Sean, Meteorological Service of Canada)
110	3	3	18	0	18	This statement give away wrong message: Glacier mass loss is determined by the prevailing weather that we calculate in annual net mass balance. The long response time ensure delayed response by the glacier in terms of glacier size and extent (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
111	3	3	18	3	19	Please specify the line of sight for this statement, as it is currently unclear. (Mastrandrea, Michael, IPCC WGII TSU)
112	3	3	19	30	46	some examples with numbers are expected (POLAND)
113	3	3	21	3	21	Where a level of confidence and summary term for agreement are provided here, the chapter team should consider presenting only the level of confidence or, alternatively, also presenting a summary term for evidence, given the framework of the uncertainties guidance. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
114	3	3	21	3	22	This statement is given to be medium confidence, high agreement, which is slightly different than all other statements that are valued in terms of evidence - I would suggest to make this uniform (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
115	3	3	21	3	22	The explanation isn't good, and offer small clarity (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
116	3	3	21	3	22	Not convinced that the significance of this point comes through - especially the second sentence. (Bunn, Stuart, Griffith University)
117	3	3	21	3	22	not sure I have correctly understood. You says that "drying of soils is projected in most dry regions". This is a change. Then you says that "projected changes in droughts depend partly on the definition of drought". I suppose you mean that the amount (of dry days) depends on the definition of drought, even if its trend, in any way the amount is defined, is well defined, because soils are drying. If this is true, I suggest to change "changes" with "trends" in line 21. Alternatively, I suggest to clarify better what you mean. (Cassardo, Claudio, University of Torino)
118	3	3	21	3	22	This finding needs elaboration based on the discussion on page 20. For example, regions are discussed in the chapter text, rather than a reference to "most dry regions," and the implications of the definition of drought are better specified. (Mastrandrea, Michael, IPCC WGII TSU)
119	3	3	24	0	0	In addition to "Renewable" water resources term, terms such as "re-usable, re-cyclable, potable, domestic" might also be more relevant in certain sentences. (Ambulkar, Archis, Brinjac Engineering Inc.)
120	3	3	24	3	25	The explanation isn't good, and offer small clarity (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
121	3	3	24	3	25	I searched for but did not find the supporting statements for this. Furthermore, what exactly is meant by "most ... regions?" How many semi-arid and arid regions are there in the world, and how many of them have projected reductions in WR? One needs to be more precise. Are we talking about fractional areas, or population-weighted areas, or subjectively geopolitically important regions of varying sizes, or...? (Milly, Christopher, U.S. Geological Survey)
122	3	3	24	3	25	Fine, but it should perhaps be mentioned either here or elsewhere in the executive summary that in other regions, renewable water resources may in principle increase due to greater precipitation, although such increases may occur only in specific seasons and may be difficult to harness effectively. (Fleming, Sean, Meteorological Service of Canada)
123	3	3	24	3	25	Section 3.5.1 (page 21) discusses the Mediterranean and South Africa only, rather than "most semi-arid and arid regions." Please reconcile. This finding also needs elaboration based on the discussion in the chapter text. (Mastrandrea, Michael, IPCC WGII TSU)
124	3	3	25	2	35	Some studies show that presence of forests is essential to maintain water availability, e.g. New York State (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
125	3	3	25	3	25	Could also reduce energy security as hydroelectric output would also fall. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
126	3	3	25	3	25	suggest re-word this to "This constitutes a key risk to food security and the environment" (refer also to 4.3.3.3) (Bunn, Stuart, Griffith University)
127	3	3	25	3	25	Where a key risk is asserted here, is it possible to indicate the potential for risk reduction via adaptation? (Mach, Katharine, IPCC WGII TSU)
128	3	3	27	3	27	If possible, it may be beneficial to specify more precisely the ways that climate change changes river flow regimes. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
129	3	3	27	3	29	by changing river flow regimes should be changed into "by changing water regimes and hydrologic situation". "due to human water withdrawals and dams" should be changed into "due to frequent human water exploitation engineering ". (Jiang, Zhongcheng, Institute of Karst Geology, CAGS)
130	3	3	27	3	29	Strongly suggest softening the wording around the phrase, "...this ecological impact may be stronger than that of historic alterations due to human water withdrawals and dams." This is an extremely bold statement, and while it may be true in some areas, it is almost certainly not true in many other regions. Perhaps preface the statement with something like, "in some areas", or follow it with something like, "but this is likely not universally true" (Fleming, Sean, Meteorological Service of Canada)
131	3	3	27	3	29	This finding should also include CC-RF in its line of sight. In addition, please specify what is meant by "may be stronger," based on the discussion in CC-RF. (Mastrandrea, Michael, IPCC WGII TSU)
132	3	3	28	3	28	Where the chapter team states that the impact may be stronger than historic alterations, is this outcome expected for all levels of climate change, for all regions, etc.? A more nuanced characterization of the multiple stressors could be beneficial. (Mach, Katharine, IPCC WGII TSU)
133	3	3	28	3	29	The second sentence is not consistent with the literature. There is certainly evidence that climate change has and will lead to changes in flow regimes and that this will have ecological consequences (refer also to CC-RF). However, with some regional exceptions, these effects are dwarfed by the impacts from modifications to flow regimes from dams, water abstraction, hydropower operation etc. (Bunn, Stuart, Griffith University)
134	3	3	31	3	32	This sentence is almost meaningless. Would anyone expect all approaches to have identical risks? (Milly, Christopher, U.S. Geological Survey)
135	3	3	31	3	36	Especially Lines 31-32 - needs to explicitly highlight the potential synergies and conflicts between mitigation and adaptation initiatives, as well as the cross-sectoral and multi-disciplinary issues. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
136	3	3	31	3	36	Based on para 3.7.2.1, the assessment on afforestation and bioenergy crops can only arrive at following primary conclusions: 1) the implementation of CDM A/R may reduce runoff in certain area, especially dry region; 2) planting bioenergy crops, such as switch grass, corn, Jatropa (Jatropa actually is a tree, not a crop) in certain condition of afforestation site, it may consume more water for irrigation. I don't think para 3.7.2.1 can support the conclusion that afforestation and bioenergy crops can consume more water than other mitigation measures. Therefore, I suggest the revision should be as follows: \nCertain approaches to reduce greenhouse gas might imply some negative effects for freshwater systems. Some bioenergy crops can require larger amounts of water for irrigation. Hydropower at large scale may cause negative effects on freshwater ecosystems, which can be reduced by appropriate management .Carbon capture and storage can decrease groundwater quality. In dry regions, afforestation can reduce renewable water resources but also flood risk (medium agreement, limited evidence).?3.7.2.1?.\n (wang, chunfeng, State Forestry Administration, China)
137	3	3	31	3	36	Especially Lines 31-32 - needs to explicitly highlight the potential synergies and conflicts between mitigation and adaptation initiatives, as well as the multi-disciplinary issues. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
138	3	3	32	3	34	Please ensure support for these statements in the chapter text. There is no comparison of water requirements for different mitigation measures, and the potential for management to reduce the negative effects of hydropower is not discussed. (Mastrandrea, Michael, IPCC WGII TSU)
139	3	3	33	3	34	This affirmation about hydropower is very emphatic maybe written as: "Hydropower CAN HAVE ANY negative effects..... (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)

#	Ch	From Page	From Line	To Page	To Line	Comment
140	3	3	33	3	34	This sentence should read: "Hydropower CAN have negative effects on freshwater ecosystems that can be reduced by appropriate management." Currently, it appears to state that hydropower will in every circumstance have negative effects which is too broad a statement to support. (Lane, Tracy, International Hydropower Association (IHA))
141	3	3	33	3	34	The comment on hydropower should be edited to say hydropower may have adverse impacts on freshwater ecosystem, I do not believe it is always the case and differentiation is needed between run of the river systems and those with storage. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
142	3	3	34	3	34	The description of "Carbon capture and storage can decrease ground water quality" should be deleted. CO2 is injected into deep saline aquifer at depth below about 900 m (typically about 1000-2000 m) in CCS operation. CCS is little relationships to freshwater accessed. (Akimoto, Keigo, Research Institute of Innovative Technology for the Earth (RITE))
143	3	3	34	3	34	Carbon capture and storage can decrease ground water quality, might lead to a misunderstanding that CCS in any regions will make problems for ground water quality, although a few number of studies for very limited areas (as mentioned in section 3.7.2.1) imply this concern. The description should be revised or deleted. (HAYASHI, Ayami, Research Institute of Innovative Technology for the Earth (RITE))
144	3	3	34	3	36	Typically sentences include "Not only" and "but also" phrases together. The present sentence can be revised as "afforestation can reduce renewable water sources and also flood risk." (Ambulkar, Archis, Brinjac Engineering Inc.)
145	3	3	35	3	36	The afforestation with a non native tree specie could create some problem, there are ther species adequate for afforestation not so water consumer. I consider the afforestation as a good measure to flood risk, stop erosion...for the water balance. Would be reasonable to highlight on the ES a particular case of malaforestation. (Suarez, Avelino, Institute of Ecology and Systematic, Cuban Environmental Agency)
146	3	3	37	3	37	Replace "to increase" by "to change" (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
147	3	3	38	3	38	Please exchange "rainfall" with "precipitation". Precipitation includes also snow, hail etc. not only liquid water. (Wurzler, Sabine, LANUV NRW)
148	3	3	38	3	39	The authors should ensure that the assessment matches the supporting text in the chapter: "Water quality changes are linked to changes in rainfall, and climate-related erosion, deforestation and will be further impacted by future warming (medium agreement, limited evidence)." (UNITED STATES OF AMERICA)
149	3	3	39	3	43	In the approach taken for interpreting uncertainty language within paragraphs of the executive summaries and summary for policymakers, the chapter team should assume that all non-bold statements have the same degree of certainty as the bold statement of the paragraph, unless otherwise specified. Thus, the repeated summary terms for evidence and agreement within the non-bold sentences of this paragraph could be deleted, as for the terms on the lines 35-36. (Mach, Katharine, IPCC WGII TSU)
150	3	3	41	0	0	More intense precipitation especially in agricultural areas increases likelihood on non-point source nutrient and sediment load to rivers, lakes and can increase eutrophication and algal blooms; what about the potential increase in blue-green algae with warmer temperatures? (CANADA)
151	3	3	42	3	42	A more qualified description of changes in storms and hurricanes may better match the assessment of working group 1. For example, a more conditional construction could be used, and possible changes in frequency and/or intensity may be relevant. (Mach, Katharine, IPCC WGII TSU)
152	3	3	45	3	46	I think the "while" in this sentence should be changed into "no matter". Therefore, the sentence should be changed as?Climate change increases investment costs in water and wastewater treatment, no matter operating costs could rise or fall. (wang, chunfeng, State Forestry Administration, China)
153	3	3	45	3	46	If possible, the chapter team might consider indicating how these risks may vary across levels of climate change. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
154	3	3	45	3	46	Please clarify whether "could rise or fall" means that costs are projected to rise in some places and fall in others, or that they could rise or fall in places where analyses have been done. (Mastrandrea, Michael, IPCC WGII TSU)
155	3	3	48	3	48	Casual usage of "likely" should be avoided as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
156	3	3	50	3	52	The last sentence of this paragraph is vague and sweeping but not informative. Provide more detail or examples to indicate how overcoming previous water supply and quality issues will inform appropriate approaches to solving climate change water issues. Otherwise delete. (Macinnis-Ng, Cate, University of Auckland)
157	3	3	51	3	52	If it is only evidence produced with the help of mathematical models or even physical models (not observations in a larger scale) it should be said in this item. (Blazkova, Sarka D., T.G. Masaryk Water Research Institute)
158	3	3	51	3	52	Is it possible to specify further what is meant by "hydrological impacts" here? All of them, the aggregate impacts, etc.? Are the increasing impacts quantifiable across levels of climate change in any sense or metric? (Mach, Katharine, IPCC WGII TSU)
159	3	3	51	3	54	Does this statement need any modification in light of the uncertainties around CO2 impacts on runoff, identified in box CC-VW? (Falloon, Peter, Met Office Hadley Centre)
160	3	3	51	3	54	In line with my general comments, it would be useful to work this element of the potential for mitigation to reduce impacts into other findings. (Mastrandrea, Michael, IPCC WGII TSU)
161	3	3	53	3	53	Casual usage of "likely" should be avoided as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
162	3	4	2	4	2	Expanding upon the concept of opportunity, is it possible to provide a more nuanced key finding here? (Mach, Katharine, IPCC WGII TSU)
163	3	4	2	4	6	How should one interpret this pairing of high agreement and low evidence with respect to adaptive water management techniques? Is IPCC saying that authors & experts agree that these techniques should hold potential, but past practice offers little evidence that they actually do? This should be clarified. (UNITED STATES OF AMERICA)
164	3	4	4	4	5	unclear what it is meant by 'resilient to uncertainty' (ITALY)
165	3	4	5	4	6	Please ensure that this statement is fully supported in the chapter text. In addition, the reference to section 3.6.2 should be 3.6.3 instead. (Mastrandrea, Michael, IPCC WGII TSU)
166	3	4	6	4	39	This caption needs some editing for grammar (Bunn, Stuart, Griffith University)
167	3	4	8	4	8	Here, it may be preferable to refer to "low regrets" improvements rather than "no regrets" improvements. (Mach, Katharine, IPCC WGII TSU)
168	3	4	9	4	10	For the described global cost of adaptation, what estimates are being referred to here? For example, it would be good to clarify what time frame is being considered & what the total global cost being referenced for this statement actually is, and to more clearly indicate whether this statement refers to the global cost of adaptation for the water sector only. On the next line, it would be helpful to specify the "amounts", in addition to comparing them to the estimates for the MDGs. (Mach, Katharine, IPCC WGII TSU)
169	3	4	10	4	11	The comparison to the MDGs is not supported by the chapter text. (Mastrandrea, Michael, IPCC WGII TSU)
170	3	4	11	4	12	I am dubious that the figures on the investment costs for adaptation in WASH are those suggested - there is insufficient evidence from developing countries to make this assessment and as these countries are those where coverage is low, resilience to climate change can be built into the design of systems now and this is unlikely to add large additional costs. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
171	3	4	11	4	12	For the described percentages, what is the relevant time frame, and what are the overall costs being referred to (beyond provided percentages)? (Mach, Katharine, IPCC WGII TSU)
172	3	4	11	4	12	Please clarify the line of sight for this statement. It appears to be based on material in 3.6.5 (page 29) that is presented in different terms. (Mastrandrea, Michael, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
173	3	4	13	4	13	In place of "low evidence," the chapter team should use "limited evidence" following the guidance for authors. (Mach, Katharine, IPCC WGII TSU)
174	3	4	13	4	14	Last sentence of paragraph - the wording doesn't seem exactly right: should this instead be "For example, wetland conservation or restoration maintains or increases carbon storage"? (Fleming, Sean, Meteorological Service of Canada)
175	3	4	19	4	19	"An adequate, and secure water supply is essential for human well being (Oki and Kanae, 2006).....". Do you really need reference for this statement? Is it not a universal truth? I think, authors are making this grandiose statement belittle by putting a reference to the statement. (Kumar, Saniiv, Center for Ocean-Land-Atmosphere Studies)
176	3	4	19	4	21	Sentence "An adequate, secure water.....and water management (Figure 3-1)" seems too long and need gramatical improvements. Probable it can be split into two sentences as "An adequate secure water supply is essential for human well-being (Oki and Kanae, 2006). Changes in the hydrological cycle can generate different water-related hazards and potentially interact with non-climatic drivers and water management (Figure 3-1)". (Ambulkar, Archis, Brinjac Engineering Inc.)
177	3	4	19	4	23	Perhaps as a last point, it would be good to point out that most of the variation in water resources in particular places over long timescales is a result of climate shifts. Even relatively small shifts during the Holocene over the past 4k years have resulted in shifts in orders of magnitude for Lake Chad, African Rift lakes, and the Nile, among many other places. And the climate link role in determining flow regime is extremely strong. Issar, Climate Changes During the Holocene and their Impact on Hydrological Systems is the now classic reference (Matthews, John, Conservation International)
178	3	4	21	0	22	Unclear or incomplete sentence (ITALY)
179	3	4	21	4	21	Change from "Water is the delivering mechanism of climate change impacts," to "Water is a primary delivering mechanism of climate change impacts." (UNITED STATES OF AMERICA)
180	3	4	21	4	22	This sentence is incomplete/lacks clarity, and the meaning is lost due to poor drafting. Suggest re-phrasing. (AUSTRALIA)
181	3	4	21	4	22	The sentence "Water is And transport." makes no sense. I think there are parts of the sentence missing. (Wurzler, Sabine, LANUV NRW)
182	3	4	21	4	23	The language is awkward, and I don't understand the first of these two sentences. (Milly, Christopher, U.S. Geological Survey)
183	3	4	22	4	23	Can the sentence be revised as "Even though water circulates on Earth and within its atmosphere, it is a locally variable source and vulnerabilities to water-related hazards differ from region to region." (Ambulkar, Archis, Brinjac Engineering Inc.)
184	3	4	26	4	30	This sentence is very long and hard to follow with a lot of different concepts incorporated. Suggest breaking the sentence up. (AUSTRALIA)
185	3	4	26	4	38	The legend for FIGURE 3-1 lacks clarity and the meaning is obscured by poor English expression (e.g. major grammatical errors, extremely long sentences, incorrect use of plural and singular forms). Suggest re-phrasing to provide clarity. (AUSTRALIA)
186	3	4	26	4	39	The language is opaque. (Milly, Christopher, U.S. Geological Survey)
187	3	4	33	4	34	The meaning of this sentence is lost due to poor drafting. (AUSTRALIA)
188	3	4	33	4	34	I suggest add: AQUEDUCT AND SEWERAGE SYSTEMS that is vital for developing countries. (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)

#	Ch	From Page	From Line	To Page	To Line	Comment
189	3	4	41	4	42	Non-climatic drivers such as population increase... Phrasing isn't quite right - while the statement is correct, it should be briefly but explicitly acknowledged here that population growth additionally serves as a major driver of anthropogenic climate change. (Fleming, Sean, Meteorological Service of Canada)
190	3	4	41	4	43	I miss pollution here. (Wurzler, Sabine, LANUV NRW)
191	3	4	42	4	42	Isuggest add: "land use AND LAND-USE CHANGES, (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
192	3	4	43	4	44	Authors should also note that actions taken to improve the reliability or sustainability of a water supply in reponse to increased population and land use changes may also be seen as useful adaptation strategies. (UNITED STATES OF AMERICA)
193	3	4	44	0	44	imprvement of what? (ITALY)
194	3	5	5	5	18	This paragraph could be tightened, compressed, and simplified. (Mach, Katharine, IPCC WGII TSU)
195	3	5	12	5	12	The word chapter will be more appropriate to be added before 11 & 12 (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
196	3	5	14	5	14	remove "below" (that section is not below but several pages later) (Cassardo, Claudio, University of Torino)
197	3	5	21	0	0	As noted earlier, this section is limited to trend tests and their results. It is important and necessary to synthesize both the methods and results of other methods: characterization of hydrological regimes, Signal Processing (spectral analysis, wavelet analysis ...) to determine the patterns of variability in hydrological signals and their origins, including mainly climate (Laignel, Benoit, University of Rouen)
198	3	5	23	6	20	Section 3.2.1: Please check and ensure consistency in D&A with Ch18 WGII and Ch10 WGI AR5. The section does not include a single reference to WGI Ch10 (except for Figure 3.2 caption); Overall, the WGII D&A concept does not seem to match entirely the one applied by WGI. Please define the applied D&A concept in order to clarify the differences between the two WGs, and also how the WGII D&A approach differs from the IPCC Good Practice Guidance Paper on D&A, the agreed on result of a cross-WGI/II Expert Meeting back in 2009. (Plattner, Gian-Kasper, IPCC WGI TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
199	3	5	25	5	36	The IPCC should use only robust detection and attribution to assess the regional to local impacts of anthropogenic global climate change. Otherwise, the IPCC is carrying a logic forward that can result in the detection and attribution of an anthropogenic climate impact where either there is no corresponding WG1 detection and attribution of an anthropogenic global climate change in relevant local to regional climate conditions, or the change in local to regional climate condition has been shown to be the result of natural climate variability, especially multiyear to multidecadal. Within the proposed approach in this chapter there is a significant under appreciation of the potential role of natural variability within "multi-step attribution, in which hydrological changes are shown to be consistent with climatic changes that may in turn be attributable to human activities." Therefore, we suggest that Chapter 3 authors adopt the language and approach used in AR5 WG2 Chapter 4, and described on page 20, lines 7-12: "Note that a slightly different definition than Chapter 18 for detection is used, because detection here is based solely on the presence of a temporal trend and does not attempt to distinguish natural from climate related variation. Confidence in attribution to climate change is very high when three criteria are satisfied: changes correspond to a sound mechanistic understanding of responses to climate change; time series of observations are sufficiently long to detect trends correlated with climate change; and confounding factors can be accounted for or are of limited importance." The approach used and described in AR5 WG2 Chapter 4 is highly defensible because it documents connections of impacts to changes in regional and local climate (both natural variability and anthropogenic climate change) and will only go further (given the challenges in making causal linkages between observed regional to local changes in climate conditions and anthropogenic climate change) when there is robust detection and attribution of the regional to local climate conditions. Using this approach, valuable information on the impacts of local to regional changes in climate can be communicated to decision makers without waiting for the robust detection and attribution of local to regional climate change that may be forthcoming as the science advances and/or time series of observations become sufficiently long to detect local to regional trends that can be demonstrated to be the result of anthropogenic global climate change. (UNITED STATES OF AMERICA)
200	3	5	25	6	20	Detection and Attribution. The terminology, methodology and definitions used in section 3.2.1 needs to be used consistently throughout the entire WG 2 document. (UNITED STATES OF AMERICA)
201	3	5	26	5	26	The following additional reference (to include at the end of line 26) is suggested "However, additional indicators, besides the rainfall amount, need to be considered when trying to understand the role of the climate. In fact, regional studies evidenced that changes in the intra annual pattern of the rainfall with statistical meaning may occur under unchanged amounts of rain, Portela and al., 2010". The complete reference is Portela, M.M.; Santos, J.F.; Quintela, A.C.; Vaz, C.; Martins, C., 2010, "About the trend detection in Portuguese long hydrologic time series and the climate change". Regional Rainfall 2010, Regional Expert Meeting on Rainfall-Runoff analysis and Climate Change at the Balkans, Faculty of Civil Engineering, University of Belgrade. Serbia and Montenegro. (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
202	3	5	26	5	26	Would it be relevant to specify that demonstrating that part of the documented changes not due to variability is done through statistics? (Mach, Katharine, IPCC WGII TSU)
203	3	5	29	5	30	This statement is ambiguous. The preface states that attribution to climate change is difficult. The statement has two interpretations:\n1. Despite the difficulty, researchers are still able to correctly attribute impacts to climate change, or\n2. In spite of this difficulty, researchers merely claim that the impacts are due to climate change confidently (in language only), but it is not rigorous.\nNeither of these statements would require some sort of evidence, as would the entire assertion of Table 3-1. Nevertheless, this appears to be a valuation statement that could be damaging to scientific credibility. In its present state, the statement and table 3-1 should be removed. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
204	3	5	30	5	32	Authors should clarify this sentence. It seems to be saying that "end to end" attribution would require running climate models with external forcings turned on and off so the two results can be compared. (UNITED STATES OF AMERICA)
205	3	5	32	5	34	I don't agree with this statement. Attribution of changes in the water cycle (a global cycle with regional and local facets) can be done at many scales, including those resolved by all (GCM-based) climate models. Indeed, one expects attribution to be successful first at the larger scales, as has been seen for temperature. (Milly, Christopher, U.S. Geological Survey)
206	3	5	43	5	46	Data series used in the references "Piao et al (2010)" is short, and attribution of runoff change in this reference was also cited from another old reference. Therefore, we add three more references to Table 3-1 instead, which are listed as follows: "Wang and Yan et al (2013), Wang and Zhang, et al (2012), Bao et al (2012), ". \nReferences\n(1) Wangm G. Q. Yan, X. L. Yan. Zhang, J.Y. et al., 2013: Detecting evolution trends in the recorded runoffs from the major rivers in China from 1950~2010. Journal of Water and Climate Change. 2013. (accepted,will be published in 2013)\n(2) Wang, G. Q. Zhang, J.Y.Pagano, T. C. et al. 2013: Identifying contributions of climate change and human activity to changes in runoff using epoch detection and hydrologic simulation. Journal of Hydrologic Engineering. 2012. doi:10.1061/(ASCE)HE.1943-5584.0000559 (accepted,will be published in 2013)\n(3) Bao, Z.X. Zhang, J.Y. et al., 2013: Attribution for decreasing streamflow of the Haihe River basin, northern China: Climate variability or human activities?". Journal of Hydrology. http://dx.doi.org/10.1016/j.jhydrol.2012.06.054 \n\n (Wang, Guoqing, Nanjing Hydraulic Research Institute)
207	3	5	46	5	46	The sentence "... long-term records of soil moisture content ..." is ambiguos and imprecise . Perhaps it should be replaced by "... long-term records of soil moisture content in natural conditions are mostly..." (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
208	3	5	48	5	51	I would suggest to add a comment to this reflection about the uncertainties in the extreme hydrological events, telling that other hydrological factors, like changes in the use of soil and vegetation can also alter the flood regime, and contributes to increase the uncertainty to attribute completely some flood changes to climatic change. (Llasat, Maria-Carmen, University of Barcelona)
209	3	5	48	5	51	important thesis - it should be repeated before the Introduction (3.1) , in the summary (POLAND)
210	3	5	48	6	10	This is an interesting discussion, and it would be beneficial to provide supporting citations for it. (Mach, Katharine, IPCC WGII TSU)
211	3	5	53	6	2	Suggest simplifying the language in this paragraph. (CANADA)
212	3	5	54	5	54	Where "threshold" is mentioned, it might be helpful to clarify that this is a threshold in a model simulation, along with the "actual climate" and "climate in which there is no anthropogenic climate change." (Mach, Katharine, IPCC WGII TSU)
213	3	6	8	6	8	There is no such thing as "anthropogenic greenhouse radiation". I guess you wanted to say "anthropogenic greenhouse forcing". (Wurzler, Sabine, LANUV NRW)
214	3	6	17	6	17	and also page 69. It is not clear to me which are the differences between the coloured lines. I mean, the real difference: how big is the difference between the "reference state"? I understand that the answer is written in the referenced paper, but I would like to understand better the figure without reading each paper... (Cassardo, Claudio, University of Torino)
215	3	6	23	6	23	In this subsection nothing is written about one of the factors: evapotranspiration. The plants transpiration is one of the main factors here, if we not have elements would be better put in the title evaporation, because evapotranspiration is different to evaporation. Maybe useful point 3.4.2 (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)

#	Ch	From Page	From Line	To Page	To Line	Comment
216	3	6	23	7	18	I find it astonishing that this section makes no reference at all to the Himalayas, Karakoram and Hindu Kush range - or indeed to the Pamirs and Tien Shan, despite continued research and publication of papers since AR4. I can only conclude the authors wish to avoid mentioning them because of previous controversy. Nonetheless, there is compelling evidence that the glaciers in this region have shown consistent loss of mass and volume when studies have used the most robust methods. A systematic review on this has recently been published (Miller et al 2012). It is not really acceptable to ignore the largest volume of ice feeding freshwater resources in this way. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
217	3	6	25	6	25	The different chapters (see also relevant comment for the SPM which makes reference to Chapter 1, p. 22, In. 49) are sometimes contradictory on what concerns past and future drought occurrence. An effort should be made to maintain consistency, by appropriately citing the literature and fully describing the assumptions/limitations in the corresponding cited works. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
218	3	6	25	6	33	You may find following reference useful here: Kumar S., V. Merwade, J. Kinter III, D. Niyogi (2013). Evaluation of Temperature and Precipitation Trends and Long-term Persistence in CMIP5 20th Century Climate Simulations. Journal of Climate. doi:10.1175/JCLI-D-12-00259.1, in press. Also, I do not agree: "models substantially underestimate observed trends (Line 30 to 31)". In the above referred paper we have shown precipitation trends from each of 19 CMIP5 models. We found that individual model's precipitation trends are comparable to observations. However, the multi-model mean generally underestimate local and regional precipitation trends. Because local/regional trends are not significantly correlated among different models (see Fig.8 in Kumar et al. 2013), mainly due to role of internal variability. This results into muted multi-model mean signal compared to observation (see Section 3.c in Kumar et al. 2013). (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
219	3	6	29	6	29	warming => warmer than before because just warming is not the reason of the changes (REPUBLIC OF KOREA)
220	3	6	29	6	30	I cannot tell what is meant by "warming" in this sentence. Is it used as shorthand for anthropogenic climate change? If so, then it is not caused by , but merely a facet of, the change. Or does it mean (as literally implied) regional changes in temperature--be they internal variability or forced? I don't think so. Also, what is meant quantitatively by "recent." I would think that most climate scientists would attribute _most_ regional, recent trends in precipitation to internal variability in the climate system. (Milly, Christopher, U.S. Geological Survey)
221	3	6	35	3	37	Please add information about the findings from Skaugen, T., Stranden, H.B., Saloranta, T. (2012) Trends in snow water equivalent in Norway (1931-2009). Hydrology Research 43 (3), p. 489-499, doi: 10.2166/nh.2012.109 as follows: In Norway, Skaugen et al. (2012) found a general negative trend in snow water equivalent below 850 masl and a positive trend in snow water equivalent above 850 masl. This indicates that at higher altitudes the observed increase in precipitation influences the snow water equivalent whereas at lower altitudes the increased temperature has reduced the snow water equivalent (a larger percentage of the percipitation is coming as rain). (Hisdal, Hege, Norwegian Water Resources and Energy Directorate)
222	3	6	35	6	36	Is it consistent to say that IPCC finds changes in snowfall to be indeterminant but changes in snowfall season are determinant? Shouldn't those two phenomena be related? Or do the authors mean that snowfall amounts could change within the season of snowfall (even if it's shortening) such that total seasonal snowfall doesn't change? (UNITED STATES OF AMERICA)
223	3	6	36	6	37	later end dates? I haven't read the references, but that seems counterintuitive, and it does not support the snowfall season. Also, is this sentence about snowfall season or snowmelt season? I am confused. (Milly, Christopher, U.S. Geological Survey)
224	3	6	37	6	37	Tedesco et al., 2009 is different than what is said here. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
225	3	6	39	3	50	It should be made clear that the "evaporation paradox" refers to evaporation and the ACTUAL evapotranspiration and not to evapotranspiration in general.(Athanasios Loukas, Civil Engineering Department, University of Thessaly, Greece) (GREECE)
226	3	6	39	6	50	This section starts out with a claim of an acceleration of the hydrologic cycle, which has been observed. There are two problems here:\nFirst, if the entire hydrologic cycle is accelerating, there should be some reference to second paragraph above that says, "Global trends in precipitation... are statistically insignificant,"in order to resolve the paradox that it suggests.\nSecondly, the evaporation paradox was hypothesized by Bouchet in response to pan evaporation liberally used to represent actual evaporation. In line 47, a decrease has been observed in pan evaporation. That was the point made in Fu et al., 2009. This is further explained in research on the evaporation paradox (and how pan evaporation does not measure actual landscape evaporation) of Hobbins et al., 2006 and Kahler and Brutsaert, 2006. (UNITED STATES OF AMERICA)
227	3	6	39	6	50	I find this paragraph unhelpful and confusing. The phrase "intensification of the hydrologic cycle" is sufficiently vague to be meaningless. Did Jung et al really analyze GLOBAL evaporation, or simply extrapolate land-based point observations to global land area (itself a minority fraction of the globe)? Oceans are where most of the global evaporation takes place. I have seen no substantial case for an "evaporation paradox;" if such a phenomenon is believed to be significant, then it would be good to give a more complete review. (Milly, Christopher, U.S. Geological Survey)
228	3	6	39	7	18	In the discussion on evaporation it is not equally clear if this considers actual or potential evaporation. The impacts on these can be quite different and it would help clarify the text by always being explicit (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
229	3	6	39	7	18	There is little discussion on the importance of feedback between precipitation and evaporation (including moisture re-circulation). This is shown by van der Ent et al., 2010 to be important in several regions of the world. A research gap is the understanding of changes to such feedback loops in a changed climate\n\nReference:\nvan der Ent, R., Savenije, H., Schaefli, B. Steele-Dunne, S., 2010, Origin and fate of atmospheric moisture over continents, Water Resour. Res., 46(9), W09525 (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
230	3	6	40	6	50	Change 'evaporative' to 'evapotranspiration' to accurately reflect the cited paper. (UNITED STATES OF AMERICA)
231	3	6	42	6	50	The evaporation paradox is announced here, with high confidence, but the rest of the chapter seems to neglect it (ITALY)
232	3	6	44	6	44	Line 39 says “ on a global scale, evaporation increased from the early 1980s up to the late 1990s “ but line 43 & 44 says regional pan evaporation has been steadily decreasing since the 1960s. It is nice to further explain how this happens. (Kazama, So, Tohoku University)
233	3	6	45	6	47	It is very difficult to accept this affirmation without a very clear explanation when the temperature is risen. We need deep in the literature with more peer review assessments. Particular heavy is this affirmation in water bodies. (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
234	3	6	45	6	50	Thanks for explaining the “evaporation paradox”. Studies have found complementary relationship between Pan Evaporation and actual Evaporation e.g. Brutsaert and 321 Parlange 1998. This complementary relationship is consistent with observation, i.e. decrease in PET and increase in ET. Is there still an “evaporation paradox”? \nReference:\nBrutsaert, W., and M.B. Parlange, 1998. Hydrologic cycle explains the evaporation paradox. Nature 396: 30 (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
235	3	6	46	6	46	Explain the definition of evaporation paradox. (Kazama, So, Tohoku University)

#	Ch	From Page	From Line	To Page	To Line	Comment
236	3	6	47	6	48	Not immediately clear why "The evaporation paradox is made more puzzling by robust oceanographic observations of changes in geographical patterns of salinity." What is it about these observations make the paradox "more puzzling"? A slightly clearer explanation would be useful. (Fleming, Sean, Meteorological Service of Canada)
237	3	6	47	6	51	This sentence is unclear. Has the contribution of canopy transpiration decline to river discharge decline been detected or modelled? Or perhaps both? (Macinnis-Ng, Cate, University of Auckland)
238	3	6	50	6	51	I didn't find Betts et al. 2007 in the reference list (Macinnis-Ng, Cate, University of Auckland)
239	3	6	52	6	52	When authors reference a "long-term record", what period duration are they implying? (UNITED STATES OF AMERICA)
240	3	6	52	6	53	Are those measurements really in "natural conditions?" Aren't they in agricultural lands--maybe artificially drained and formerly plowed--on carefully tended plots of grass? (Milly, Christopher, U.S. Geological Survey)
241	3	6	53	6	54	If possible, it would be preferable to specify the timeframe for this observed change. (Mach, Katharine, IPCC WGII TSU)
242	3	7	1	7	8	If possible, the timeframe for these observations should be specified. (Mach, Katharine, IPCC WGII TSU)
243	3	7	8	7	10	The sentence "Soil humidity in permafrost areas and permafrost degradation are strongly connected with active layer depth and influence the stability of steep slopes" is very confusing. There is a mix of concepts. By analysing what you might want to say, I think you mean that on one side "Active layer depth and permafrost degradation are closely dependent on soil ice content. In steep terrain, slope stability is highly affected by changes in permafrost". If needed, I will be happy to re-review or clarify questions in rephrasing. I suppose this problem might have arised due to shortening of sentences. (Vieira, Goncalo, University of Lisbon)
244	3	7	14	7	16	If possible, the timeframe for these changes should be specified. (Mach, Katharine, IPCC WGII TSU)
245	3	7	21	0	0	Section 3.2.3. The period when observed trends have been recorded should always be specified, as upward and downward trends may be observed over different periods, as shown by Giuntoli et al. (2013) in France and Hannaford et al. (2013) over different European regions, because of decadal oscillations in some climate characteristics. The list of detected trends in this paragraph must therefore be accompanied by the corresponding studied period in order to avoid potentially large misinterpretations.\n- Giuntoli, I., Renard, B., Vidal, J.-P., and Bard, A. (2013) Low flows in France and their relationship to large-scale climate indices. Journal of Hydrology, 482, 105-118. doi: 10.1016/j.jhydrol.2012.12.038\n- Hannaford, J., Buys, G., Stahl, K., and Tallaksen, L. M. (2013) The influence of decadal-scale variability on trends in long European streamflow records. Hydrology and Earth System Sciences Discussions, 10, 1859-1896. doi:10.5194/hessd-10-1859-2013 (Vidal, Jean-Philippe, Irstea)
246	3	7	21	0	0	This part is incomplete. This lack of references, including all work on the relationship between hydrological variability and climate fluctuations and the presence of discontinuities that are not presented. Similarly, work from satellite data are not presented. (Laignel, Benoit, University of Rouen)
247	3	7	21	7	21	The recent work by Fritze et al. (2011; J Hydrometeorology,12, 989, DOI: 10.1175/2011JHM1360.1) sheds some additional observations of shifts in western North American snowmelt runoff for the 1947 to 2008 period. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
248	3	7	21	7	45	Section 3.2.3 - Mention is made of possible effects on runoff of changes in transpiration of vegetation. In particular, increases in CO2 concentration, and subsequent increases in stomatal conductance in vegetation and reduced transpiration can lead to increases in global runoff. What is not mentioned in this paragraph are indirect effects of changes in precipitation and temperature through their effects on vegetation water use. In particular, the effects of changes in climate on the severity and frequency of events such as wildfire and pests and pathogens that can significantly change the water balance of vegetated areas. Changes in regimes of wildfire and in pests and diseases that result from changes in precipitation and temperature can potentially change evapotranspiration from vegetation canopies. For example, increased infestations of mountain pine beetle and subsequent forest mortality in Canada are likely to lead to accumulation of a larger snowpack as a result of thinner tree canopies and decreased snow sublimation (Pugh and Small, 2011). These thinned canopies also cause faster snow melt by allowing more sunlight through to the forest floor and lowering the snowpack albedo, as a result of needle litter on the snow surface. Augmented snowpack coupled with dead trees that no longer transpire will likely lead to more available water. Wildfire induced tree mortality has the potential to decrease streamflow in some forested catchments, as post-fire regeneration can lead to increases in evapotranspiration for several decades. Pugh, E., Small, E. 2011. The impact of pine beetle infestation on snow accumulation and melt in the headwaters of the Colorado River. Ecohydrology, DOI: 10.1002/eco.239. Kuczera, G.A. 1987. Prediction of water yield reductions following a bushfire in ash-mixed species eucalypt forest. J. Hydrol. 94, 215–236. (AUSTRALIA)
249	3	7	23	7	31	in my opinion, annual trends are not so meaningful. In several regions, seasonal trends are much bigger but sometimes are opposite between different seasons and so cancel each other, giving annual values less meaningful. For instance, since precipitation is the main source for aricultural purposes, the analysis of runoff during the vegetative season is a key point! (Cassardo. Claudio. University of Torino)
250	3	7	23	7	31	The geographical coverage of this passage seems totally inadequate. Far more examples of overall water resource trends are needed here, and are available. For instance, the one-sentence summary about runoff changes across North America looks only at the US, to the exclusion of Canada and Mexico; and it is not even adequately descriptive of what is happening in the US. As one recent and relevant example, Fleming and Weber (2012) found that runoff has been steady or increasing across British Columbia, including the upper (Canadian) portion of the transboundary Columbia Basin, the largest river by runoff volume on the west coast of the Americas. There have also been many other analyses across North America. And then, of course, there is the rest of the world - again, insufficient geographic coverage is provided here. This appears to be the main location in the IPCC report that global runoff trends, one of the most significant impacts of climate change, are summarized. More detail is required here, as the current description is incomplete and potentially misleading. (The reference for the above citation is: Fleming SW and Weber FA (2012) , Detection of long-term change in hydroelectric reservoir inflows: bridging theory and practise, Journal of Hydrology, 470/471: 36-54). (Fleming, Sean, Meteorological Service of Canada)
251	3	7	23	7	39	Clarify that all changes in river basins mentioned are either at river stations that are unregulated, or that the discussion is on naturalised flows. Several of the basins mentioned are highly regulated (Yellow River, Columbia River). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
252	3	7	23	7	45	<p>Good start, but credibility and accuracy demands that this section (3.2.3) include some additional text around the impacts of glaciers on observed runoff trends, as this is a key issue in many parts of the world (i.e., rivers like the Danube, Columbia, Ganges, Yellow, etc with headwaters in the Alps, Himalayas, Rockies, Andes, etc). Such text would also help tie the contents of this section to the other sections in the chapter, e.g., 3.2.2. Just a short but accurate paragraph would be sufficient. Here is a suggestion:</p> <p>"Runoff trends associated with glacier change in a warming environment have been documented worldwide. The presence or absence of glacial ice in a mountain watershed can control the strength and even direction of local runoff trends. Further, glaciers have been observed to generate either increasing or decreasing water resource trends historically, depending on how far down the path of deglaciation a particular catchment is located." Eight key literature citations (this is a minimum required set, more could be legitimately cited) include the following: (i) Fleming SW and Clarke GKC (2003), Glacial control of water resource and related environmental responses to climatic warming: empirical analysis using historical streamflow data from northwestern Canada, Canadian Water Resources Journal, 28:69-86; (ii) Stahl K and Moore RD (2006), Influence of glacial coverage on summer streamflow in British Columbia, Canada. Water Resources Research, 42, doi:10.1029/2006WR005022; (iii) Casassa G and others (2009), Detection of changes in glacial run-off in alpine basins: examples from North America, the Alps, central Asia, and the Andes, Hydrological Processes, 23:31-41; (iv) Moore RD and others (2009), Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality, Hydrological Processes, 23:42-61; (v) Li Z and others (2010), Observed changes in streamflow at the headwaters of the Urumqi River, eastern Tianshan, central Asia, Hydrological Processes, 24:217-224; (vi) Baraer M and others (2012), Glacier recession and water resources in Peru's Cordillera Blanca, Journal of Glaciology, 58, doi:10.3189/2012JoG11J186; (vii) Fleming SW and Weber FA (2012), Detection of long-term change in hydroelectric reservoir inflows: bridging theory and practice, Journal of Hydrology, 470-471:36-54; and (viii) Dahlke HE and others (2012), Contrasting trends in hydrologic extremes for two sub-arctic catchments in northern Sweden: does glacier melt matter?, Hydrology and Earth System Science, 16:2123-2141. (Fleming, Sean, Meteorological Service of Canada)</p>

#	Ch	From Page	From Line	To Page	To Line	Comment
253	3	7	23	7	45	This section talks about "flows" but almost nothing until the last paragraph about flow regime. As flow regime is both the "master variable" for freshwater ecosystem and tightly linked to precipitation regime (Poff, BioScience, 1997), a series of strong statements are really necessary here. Quantity and quality are both linked intimately to flow regime/water timing, and one of the real weaknesses of climate models to date is that they tend to be presented and analyzed at annual timescales. In part this is because this maximizes confidence, but it also masks very significant intra-annual changes that may be occurring at a seasonal scale, which is far more important for livelihoods, economies, infrastructure, and ecosystems. In talks, I sometimes explain that I have killed a lot of plants by watering them two weeks too late, though the amount of water that I applied at an annual scale looks identical to a "good" harvest year. This is also a key point in Matthews/Wickel/Freeman, PLoS Biology, 2011. In terms of the major shifts for the AR5, flow regime is likely to be the driver of "transformation" (to use the excellent term suggested in the first two chapters) for freshwater resources. Shifts from perennial to intermittent, for instance, constitute transformation by essentially any definition. Lastly, I think it is also important to consider shifts in precip timing in particular for a variety of sectors. This is not really discussed in significant detail, but there is evidence that these shifts are occurring. Reports from the past few years in Kenya, for instance, see a clear identification of "drought" conditions by farmers and urban water managers though regional meteorological patterns show slight increases in annual precip. The gap is in the timing of precipitation. The increasing variability of the Indian Monsoon is having the same effect in South Asia. In China's Qinghai, there is evidence from herders and farmers that intense spring rains are a transition in the past 15 years from previous spring "misting" conditions, which herders call "winter drought". The resulting rains trigger massive erosion and grassland degradation over a widespread area. Timing is one of the most critical aspects of water and our use and orientation to water, and I think it deserves a more significant treatment here. (Matthews, John, Conservation International)
254	3	7	24	7	24	It is better to give a quantitative analysis other than qualitative . (Kazama, So, Tohoku University)
255	3	7	24	7	24	If possible, the timeframe for these observed changes should be specified. (Mach, Katharine, IPCC WGII TSU)
256	3	7	24	7	25	Lower streamflow in Europe expected, particularly in south and east. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
257	3	7	26	7	27	There are many stream flow trends studies in North America, particularly in the United States e.g. Kumar et al. 2009. Also, trends should be discussed also with its statistical significance and uncertainties in statistical significance. For example: in Kumar et al. 2009, we found that number of stations showing significant trends gets considerably reduced when we consider long-term persistence in stream flow trends. Reference: Kumar, S., V. Merwade, J. Kam and K. Thurner (2009), Streamflow trends in Indiana: effects of long term persistence, precipitation and subsurface drains, Journal of Hydrology, Vol. 374 (1-2), pp. 171–183 (Kumar, Saniiv, Center for Ocean-Land-Atmosphere Studies)

#	Ch	From Page	From Line	To Page	To Line	Comment
258	3	7	27	7	29	Data series used in the references “Piao et al (2010)” is short, and attribution of runoff change in this reference was also cited from another old reference. Therefore, we add three more references to illustrate changes in runoff and stream flow in Line 27-29, Page 7 as follows, “In china, recorded runoffs of the major rivers have all presented decreasing trends, with detectable significant decreases occurring in the most of the northern rivers (Wang et al, 2013). Declining flows in the Yellow and Haihe river basins are mostly due to human activities including land use change, human consumption etc (Wang and Zhang, et al, 2013; Bao et al, 2012), whereas climate change is already a major factor affecting the Yangtze and Pearl Rivers (Wang and Yan, et al, 2013)” References (1) Wang, G. Q. Yan, X. L. Zhang, J.Y. et al. 2013: Detecting evolution trends in the recorded runoffs from the major rivers in China from 1950~2010. Journal of Water and Climate Change. 2013. (accepted and will be published in 2013) (2) Bao, Z.X. Zhang, J.Y. et al., 2012: Attribution for decreasing streamflow of the Haihe River basin, northern China: Climate variability or human activities?”. Journal of Hydrology. 2012. http://dx.doi.org/10.1016/j.jhydrol.2012.06.054 (3) Wang, G. Q. Zhang, J.Y. Pagano, T. C. et al, 2013: Identifying contributions of climate change and human activity to changes in runoff using epoch detection and hydrologic simulation. Journal of Hydrologic Engineering. 2012. doi:10.1061/(ASCE)HE.1943-5584.0000559 (accepted,will be published in 2013) (Wang, Guoqing, Nanjing Hydraulic Research Institute)
259	3	7	29	7	31	The cautions from Jones, 2011, are important, but they're secondary relative to the issue of misinterpreting whether local trends in hydroclimate are linked to past global climate change rather than to past natural climate variations and teleconnection. Narrative should address the latter. (UNITED STATES OF AMERICA)
260	3	7	33	7	33	Significant with respect to what null hypothesis, based on what assumed model of internal variability? Would fewer trends be significant if a more realistic model of persistence were allowed? On the other hand, why is the word "only" used? It seems to imply that we are seeing less change than we should if ACC is real, but that's not the case, in my opinion. (Milly, Christopher, U.S. Geological Survey)

#	Ch	From Page	From Line	To Page	To Line	Comment
261	3	7	33	7	39	This passage, examining trends in "simulated" (i.e., presumably model-based) discharges, is potentially useful - but it has some problems, and has not been well-integrated into the remainder of the content of Section 3.2.3. I suggest making 4 changes to this passage. (1) Move this passage to the end of Section 3.2.3. (2) Precede the passage by something like the following: "Observational assessments of the hydrologic impacts of climate change are necessarily and justifiably based primarily on statistical and time series analysis of historical datasets. However, a very small proportion of the world's rivers have hydrometric records of sufficient length and quality to permit credible climate impact analysis. Important complements to such work are therefore provided by both model-based assessments and paleohydrologic studies." (3) Adjust the passage itself slightly. Note that the trend analysis results are only as good as the model used to generate the "data." There appear to be errors in the summary statement as well, e.g., streamflows have not been decreasing uniformly across "Western Canada," as in fact flows in British Columbia (for example) have been constant or increasing at many locations. (4) Follow this passage with a brief discussion of paleohydrologic results. Here is a suggestion: "Proxy-based estimates of pre-instrumental streamflows, though also having limitations, are another valuable means for providing long-term context on hydroclimatic change. For example, dendrochronological reconstructions of flows for the Colorado (USA; e.g., Meko et al., 1995) and Saskatchewan (Canada; e.g., Fleming and Sauchyn, 2013) basins in the dry western interior of the North American continent have revealed that the late 19th and early 20th centuries - when large-scale settlement and conversion to agricultural and other land uses occurred, and precedents were set for water use and allocation - were far wetter (e.g., Cook et al., 2011) than typical over the long term for these regions. In fact, for the Saskatchewan River, the most anomalous water supply availability, volatility, and stability conditions of the last 1000 years may have occurred during this period (Fleming and Sauchyn, 2013). Such results have implications for understanding both the broader significance of shifts recorded in the much shorter instrumental record, and how larger-than-previously recognized natural variations may superimpose on anthropogenic climate change impacts." The full citations for the references cited above are: (i) Cook BI and others (2011), On the causes and dynamics of the early twentieth-century North American pluvial, <i>Journal of Climate</i> , 24:5043–5060; (ii) Meko DM and others (1995), The tree-ring record of severe sustained drought, <i>Journal of the American Water Resources Association</i> , 31:789–801; and (iii) Fleming SW and Sauchyn DJ (2013), Availability, volatility, stability, and teleconnectivity changes in prairie water supply from Canadian Rocky Mountain sources over the last millenium, <i>Water Resources Research</i> , 118:1-11. (Fleming, Sean, Meteorological Service of Canada)
262	3	7	34	7	34	Which is level of significance? (Kazama, So, Tohoku University)
263	3	7	34	7	34	The follwoing additional reference (to include in line 34 after the period finishing in "processes.") is suggested "Another study for the South-western Europe also showed a decrease in the frequency of the flood events since the 1960's as well as a close connection between the occurrence of such events and the cyclic behaviour of the winter NOA indices, Silva et al., 2012". The complete reference is Silva, A. T., Portela, M. M., and Naghettini, M., 2012, "Nonstationarities in the occurrence rates of flood events in Portuguese watersheds", <i>Hydrol. Earth Syst. Sci.</i> , 16, 241-254, doi:10.5194/hess-16-241-2012. (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
264	3	7	37	7	39	Decrease of plant transpiration is not proper place under topic of "runoff and stream flow", because it is about decrease of stomatal opening of crop or plant species that influenced from temperature and slightly related to runoff and stream flow. Actually, it should move to evapotranspiration section. (Kazama, So, Tohoku University)

#	Ch	From Page	From Line	To Page	To Line	Comment
265	3	7	37	7	39	"global increase in runoff ... reduced transpiration" . In previous page (Page 6, Line 39 to 50), you have discussed increase in evaporation (I guess, you are talking about evapotranspiration), and now you are saying decrease in transpiration. Is it not contradictory? Also, you are missing one major driver of runoff trend that is precipitation trends at local/regional scales (e.g. Kumar et al. 2009; McCabe and Wolock, 2002).\nReference:\nKumar, S., V. Merwade, J. Kam and K. Thurner (2009), Streamflow trends in Indiana: effects of long term persistence, precipitation and subsurface drains, Journal of Hydrology, Vol. 374 (1-2), pp. 171–183\n\nMcCabe, G.J., Wolock, D.M., 2002. A step increase in streamflow in the conterminous United States. Geophysical Research Letters 29 (24), 2185. doi:10.1029/ 2002GL015999. (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
266	3	7	41	7	43	This statement would benefit from further refinement. Because decreases in the wintertime snow:rain ratio also affect basins with dual winter-rain and spring-snowmelt freshets, such as are very common in Pacific coastal North America for instance, I strongly suggest changing "...has increased winter low flows..." to "...has increased winter flows..." (i.e., just omit the word "low"). Some additional references are needed as well; a good example is Cannon AJ (2005), Defining climatological seasons using radially constrained clustering, Geophysical Research Letters, 32, doi:10.1029/2005GL023410. There are certainly other papers which should probably be referenced here as well. (Fleming, Sean, Meteorological Service of Canada)
267	3	7	41	7	45	If possible, the timeframe over which these changes have been observed should be specified. (Mach, Katharine, IPCC WGII TSU)
268	3	7	43	7	43	Add the refernces Stahl et al., 2010 and Wilson et al., 2010 (already in the reference list) as these papers also focus on low flows (Stahl et al.) and floods (Wilson et al.) (Hisdal, Hege, Norwegian Water Resources and Energy Directorate)
269	3	7	44	7	44	Smith, 2000: this reference is old. (Sjostrom, Asa, Swedish Meteorological and Hydrological Institute)
270	3	7	44	7	44	Smith, 2000: this reference is old. (SWEDEN)
271	3	7	44	7	45	It isn't clear whether this sentence is meant to be true in general, or to apply only to places with seasonal snow storage. I think it is the latter, but this should be made more clear. (Milly, Christopher, U.S. Geological Survey)
272	3	7	44	7	45	Should be "Where stream flow is low in summer", not "lowest". Decreases in late-summer low-flows exist and are practically important even in hydroclimatic regions where the very lowest flows of the year occur in a season other than summer. It should perhaps also be noted here that these climatically driven changes in summer low flows can be deeply exacerbated by urbanization and certain watershed management practises. (Fleming, Sean, Meteorological Service of Canada)
273	3	7	45	7	45	It is suggested to include a reference to Stahl et al. (2010) also here - see above comment (Hisdal, Hege, Norwegian Water Resources and Energy Directorate)
274	3	7	48	0	0	As already mentioned in my previous review, this section is very punctual and insufficient. There are many other works concerned with the evolution of groundwater. (Laignel, Benoit, University of Rouen)
275	3	7	48	0	0	This section is terribly inadequate. At a minimum, there are different types of groundwater, of different ages and sources. Groundwater is in many ways like an underground glacier and can be "mined" and profoundly and permanently exploited, at least by any meaningful human timescale. The ancient water from the central US Plains is an example of water that is essentially not replenishable in many regions, and some maps suggest that eastern portions may be showing rising water levels in recent decades while other are declining quite rapidly as a result of increasing demand (due in part to higher ET rates from increased drought/dry period duration). New USGS groundwater ref: http://pubs.usgs.gov/sir/2013/5079/ (Matthews, John, Conservation International)

#	Ch	From Page	From Line	To Page	To Line	Comment
276	3	7	48	8	6	Here are not descriptions of relationship to flooding and GW temperature. Kazama et al.(Evaluation of groundwater resources in wide inundation areas of the Mekong River basin, Journal of Hydrology, 3-4, 340, pp.233-243, 2007) pointed out groundwater decrease caused by urban area expansion and less rainfall. Gunawardhana, et al. (Statistical and numerical analyses of the influence of climate variability on aquifer water levels and groundwater temperatures: The impacts of climate change on aquifer thermal regimes, Global and Planetary Change, Vol.86-87, pp.66-78, 2012) mentioned the increase of GW temperature and it influences lowland ecosystem. (Kazama, So, Tohoku University)
277	3	7	48	8	6	3.2.4 Groundwater shows that observed change of groundwater level,storage and discharge to climate change is difficult,and the groundwater discharge decrease with precipitaion decrease and temperature increase by using two case study respectively.I think that the context of this part is not perfect. Firstly, groundwater is called as "the continental paleo-climatic archives"(FONTES J C, STUTE M, SCHIOSSER P, et al. Aquifers as archives of paleoclimate. EOS Trans AGU, 1993, 74:21 (Jiang, Zhongcheng, Institute of Karst Geology, CAGS)
278	3	7	50	8	6	Inasmuch as it is difficult to ascertain impacts of current climate change on groundwater, it is perhaps instructive to examine (or not forget) studies of historical (paleohydrologic) impacts on groundwater (as noted in Taylor et al., now 2013, not 2012). Some subsurface regimes still exhibit transient hydrologic relaxation effects (c.g., Tyler et al., 1996, Water Resour. Res., 32(6), 1481; et al., 2010, Glob. Plan. Change, 72, 412) from those time periods, suggesting, in some cases, that defining "baselines" against which contemporary changes may be compared need to be carefully considered. (UNITED STATES OF AMERICA)
279	3	7	50	8	6	Section 3.2.4 is well-done, but I might suggest also adding something like the following: "Also, for deeper or confined aquifers more isolated from driving climate, it can be challenging to robustly detect climate-groundwater interactions." (Fleming, Sean, Meteorological Service of Canada)
280	3	7	52	0	0	The sentence needs revision such as "The extent to which groundwater abstractions have already been affected by climate change is not known." (Ambulkar, Archis, Brinjac Engineering Inc.)
281	3	8	1	8	2	If possible, the timeframe for these observed changes should be specified. (Mach, Katharine, IPCC WGII TSU)
282	3	8	2	0	0	Define PDSI (Macinnis-Ng, Cate, University of Auckland)
283	3	8	5	8	5	Changes in evapotranspiration cannot be attributed to temperature changes alone. The study (Aguilera and Murillow, 2009) used a simplistic empirical model using monthly values of precipitation and temperature. The authors noted the need for finer temporal resolution. There is also a need for a biophysically based model. (UNITED STATES OF AMERICA)
284	3	8	5	8	5	Temperature increase does not cause more evaporation; energy availability--mainly net radiation--causes evaporation. Reduced evaporation causes warming more than warming causes more evaporation. (Milly, Christopher, U.S. Geological Survey)
285	3	8	9	0	0	Please carefully check the calibrated language in this section, as usage is currently nonstandard. Each usage should either present a level of confidence or descriptors for both evidence and agreement (not evidence or agreement alone). Ideally, a consistent approach should be adopted across the chapter. (Mastrandrea, Michael, IPCC WGII TSU)
286	3	8	9	9	6	Section 3.2.5 - A number of potential effects of climate change on water quality are discussed. One omission is that of the effects of wildfire on water quality. Many cities around the world rely on good quality water from forested catchments that requires very little treatment. The increased risk of wildfire frequency and severity in these areas could have severe consequences on the quality of water derived from these catchments. Hugh G. Smith , Gary J. Sheridan, Patrick N.J. Lane , Petter Nyman, Shane Haydon 2011. Wildfire effects on water quality in forest catchments: A review with implications for water supply. Journal of Hydrology 396: 170-192 (AUSTRALIA)

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287	3	8	9	9	6	I miss a word about the role of air pollutants on water quality as well as on the effects of increased meat consumption and thus increased stock farming and thereby increased liquid manure on water quality. (Wurzler, Sabine, LANUV NRW)
288	3	8	11	8	39	Water quality usually is more influenced by human activity, so the context should add impact of human on water quality. (Kazama, So, Tohoku University)
289	3	8	11	9	2	I think this section is saying mainly that climate affects water quality, while not making any kind of two-step claims related to climate change. Am I correct? Can the message be made more clear? Page 8 line 47-49 is acknowledged, but even it fails to mention that local climatic variability tends to be dominated by internal variability in the climate system. (Milly, Christopher, U.S. Geological Survey)
290	3	8	12	8	13	The authors should consider deleting 'change' to read "Some observed impacts of climate on water quality are included in Table 3-1." The second sentence of the table caption points out "Observed hydrological changes are attributed here to their climatic drivers, **which are not all known to be anthropogenic**." (UNITED STATES OF AMERICA)
291	3	8	13	8	15	This passage seems to imply that water temperature is distinct from water quality - many would disagree, suggesting that water temperature is a form of water quality. I would suggest refining the wording here. (Fleming, Sean, Meteorological Service of Canada)
292	3	8	14	8	14	We recommend that authors insert 'multidecadal' to read 'are linked to either seasonal, interannual, or multidecadal variations in any of several variables. (UNITED STATES OF AMERICA)
293	3	8	15	8	16	Is this sentence necessary?: "Droughts and the El Nino Southern Oscillation (ENSO) phenomenon can also affect water quality." It is true that droughts and ENSO affect water quality but so do other phenomena such as heat waves, extreme precipitation events, floods, and multidecadal climate oscillations. (UNITED STATES OF AMERICA)
294	3	8	15	8	16	I would suggest clarifying this text by adding "Natural variability, such as..." before "Droughts and the El Nino..." (Fleming, Sean, Meteorological Service of Canada)
295	3	8	15	8	16	Drought and El Nino can affect water quality: very generic and without references. (ITALY)
296	3	8	18	8	18	Do you mean more intense algal blooms rather than eutrophication. The latter refers to the nutrient status, so this would imply that the loading increases with temperature. (Bunn, Stuart, Griffith University)
297	3	8	18	8	29	One consequence of warmer temperatures, particularly in temperate regions, is the increased incidence of blue-green algal blooms, which tend to dominate under warmer conditions - and the risk of toxic forms. Also, more prolonged and intense thermal stratification and the increased thermal stability can lead to additional water quality problems in lakes and reservoirs. (Bunn, Stuart, Griffith University)
298	3	8	20	8	25	It would be preferable to specify the relevant geographic area and timeframe for this observed effect. (Mach, Katharine, IPCC WGII TSU)
299	3	8	20	9	5	In these paragraphs, where levels of confidence and summary terms for agreement are presented together, the chapter team should consider 2 alternatives that would be preferable: 1) presenting only a level of confidence, or 2) presenting a level of confidence and summary terms for BOTH evidence and agreement (Mach, Katharine, IPCC WGII TSU)
300	3	8	21	8	21	Insert reference Boxall et al: Boxall ABA, Hardy A, Beulke S, Boucard T, Burgin L, Falloon PD, Haygarth PM, Hutchinson T, Kovats RS, Leonardi G, Levy LS, Nichols G, Parsons SA, Potts L, Stone D, Topp E, Turley DB, Walsh K, Wellington EMH, Williams RJ (2008). Impacts of Climate Change on the Health Risks of Pathogens and Chemicals from Agriculture. Environmental Health Perspectives, 117, 508-514. doi:10.1289/ehp.0800084 (Falloon, Peter, Met Office Hadley Centre)

#	Ch	From Page	From Line	To Page	To Line	Comment
301	3	8	25	8	26	Please note that, in the guidance for authors, a level of confidence is assigned based on the chapter team's evaluation of evidence and agreement. Thus, a level of confidence here should be based on summary terms for evidence and agreement, not vice versa. (Mach, Katharine, IPCC WGII TSU)
302	3	8	26	0	26	reservoir in (ITALY)
303	3	8	26	8	26	Typo. "In a reservoirin Spain....." Please correct to "In a reservoir in Spain....." (Athanasios Loukas, Civil Engineering Department, University of Thessaly, Greece) (GREECE)
304	3	8	26	8	27	Terms "reserviorin" and "increasesin" should be "reservior in" and "increases in" respectively. (Ambulkar, Archis, Brinjac Engineering Inc.)
305	3	8	26	8	27	two times the preposition "in" is attached to the previous word "reservoirin" and "increasesin" (Cassardo, Claudio, University of Torino)
306	3	8	27	8	27	Typo. "... temperature increasesin...." Please correct to ".... Temperature increases in....."(Athanasios Loukas, Civil Engineering Department, University of Thessaly, Greece) (GREECE)
307	3	8	28	8	29	States that nutrients could be flushed from lakes and estuaries by more frequent storms, reducing eutrophication and algal blooms. But, lines 31-32 state increased runoff from storms might make the situation in rivers worse. Could increased runoff into lakes also worsen eutrophication? (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
308	3	8	29	8	29	A more qualified description of changes in storms and hurricanes may better match the assessment of working group 1. For example, a more conditional construction could be used, and possible changes in frequency and/or intensity may be relevant. (Mach, Katharine, IPCC WGII TSU)
309	3	8	31	8	31	For the phrase "all of the reported impacts," is not completely clear what impacts are being referred to--"all assessed impacts"? (Mach, Katharine, IPCC WGII TSU)
310	3	8	31	8	36	Only higher runoff is mentioned as a reason for higher pollutant concentrations in rivers. On the other hand, in chapter 28 (Polar regions, page 8 onwards) higher temperature has increased nutrient and humic acid loadings from catchments to watersleading to changes in species composition. (Rankinen, Katri, Finnish Environment Institute)
311	3	8	33	8	34	Insert reference Boxall et al: Boxall ABA, Hardy A, Beulke S, Boucard T, Burgin L, Falloon PD, Haygarth PM, Hutchinson T, Kovats RS, Leonardi G, Levy LS, Nichols G, Parsons SA, Potts L, Stone D, Topp E, Turley DB, Walsh K, Wellington EMH, Williams RJ (2008). Impacts of Climate Change on the Health Risks of Pathogens and Chemicals from Agriculture. Environmental Health Perspectives, 117, 508-514. doi:10.1289/ehp.0800084 (Falloon, Peter, Met Office Hadley Centre)
312	3	8	37	8	39	Why temperature has more influence than precipitation? (Rankinen, Katri, Finnish Environment Institute)
313	3	8	41	8	41	Suggest changing the wording slightly to "Studies of groundwater quality responses to climate change are still limited." (Fleming, Sean, Meteorological Service of Canada)
314	3	8	41	8	45	I wonder if there were any studies of nutrient concentrations available, e.g. related to Nitrates Directive in Europe. This sounds now that only studies of faecal pollution were included. (Rankinen, Katri, Finnish Environment Institute)
315	3	8	41	8	45	Why do the authors not provide any references on faecal pollution and groundwater during heavy rainfall events despite these being numerous in both developed and developing countries? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
316	3	8	47	8	47	Delete 'variability' to read "Linkages between observed effects on water quality and climate should be interpreted cautiously, at a local level, considering the type of water source and pollutant, the hydrological regime and the sources of pollution (high confidence, high agreement)." It is unclear why the text states: 'Linkages between observed effects on water quality and climate variability should be interpreted cautiously.' Why only the caution with in linkages between observed effects on water quality and climate variability, should there be a similar caution in linkages between observed effects on water quality and climate change? (UNITED STATES OF AMERICA)
317	3	8	53	9	2	The sentence starting with "If the observed deterioration of water quality..." seems unsupported by the cautions and uncertainties identified before it in this paragraph. Please reconcile. (UNITED STATES OF AMERICA)
318	3	9	9	0	0	As already mentioned in my previous review, in the parameters outlined in influencing soil erosion and sediment fluxes, it lacks the geomorphological parameters such as area, elevation. Further work could be cited. Moreover, there is confusion about the role of dams on soil erosion and sediment fluxes. The presence of the dam reduces the amount of sediment reaching the mouth, but does not protect the soil from erosion and does not reduce soil erosion remains the same. (Laignel, Benoit, University of Rouen)
319	3	9	9	9	44	Section 3.2.6 - Soil Erosion and sediment loads are discussed as a function of changes in precipitation erosivity. Little mention is given the role of vegetation in erosion control, and therefore the risk of increased erosion after changes in vegetation structure. For example, high-magnitude erosion events after wildfire have been documented in south-eastern Australia. Petter Nyman, Gary J. Sheridan, Hugh G. Smith, Patrick N.J. Lane, 2011. Evidence of debris flow occurrence after wildfire in upland catchments of south-east Australia. Geomorphology 125: 383–401. (AUSTRALIA)
320	3	9	9	9	44	Wind-born erosion of soils is not mentioned here – could add a link to the relevant chapter. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
321	3	9	9	9	44	The phrases "low confidence" and "limited evidence" are clear. However the statement on line 43 that "human impacts are more significant" is not well supported, so the last sentence of this section could be deleted. (UNITED STATES OF AMERICA)
322	3	9	11	9	11	Another paper worth referencing used an ensemble of regional climate models to assess freshwater availability: Sanderson, Wiltshire and Betts, Potential impacts of climate change on water resources in the United Kingdom, Water Resources Res., 48, No.8, doi:10.1029/2012WR011881 (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
323	3	9	11	9	16	The distinction between projections and observations should be carefully considered in this paragraph. In the 1st sentence, it is unclear if the "expected" effect is referring to observed or projected changes. As much as possible, the paragraph should remain focused on sensitivities, vulnerabilities, and observed impacts given the scope of this section. (Mach, Katharine, IPCC WGII TSU)
324	3	9	13	9	14	Calling snow "non-erosive" and rainfall "erosive" seems a bit oversimplistic - this passage would benefit from refined wording. (Fleming, Sean, Meteorological Service of Canada)
325	3	9	14	9	14	melting of permafrost - thawing is a more appropriate word. The reference to Kundzewicz et al. (2007) is outdated and inappropriate as they do not specifically study permafrost melt. Please see section 3.2.2 or refer to the corresponding chapter in WG1. (Dankers, Rutger, Met Office Hadley Centre)
326	3	9	14	9	15	It is mentioned "melting of permafrost" but permafrost does not melt, it thaws. Therefore, replace with "thawing of permafrost". In next line, it should read "obscured" and not "obscure". (Silva Mora, Carla Andreia, University of Lisbon)
327	3	9	15	9	15	add "d" after "obscure" (Cassardo, Claudio, University of Torino)
328	3	9	18	0	23	This section is hard to follow - suggest reviewing and revising. (CANADA)

#	Ch	From Page	From Line	To Page	To Line	Comment
329	3	9	18	9	18	It is not clear about how many "reduced precipitation" can contribute about 30% to a total reduction in sediment yield during 1970-2008, I suggest the reduced precipitation should be given or expressed in quantitative result. (wang, chunfeng, State Forestry Administration, China)
330	3	9	18	9	23	The paragraph cum sentence is too long to comprehend. Please split it into more than one sentence for easier understanding of the readers. (Ambulkar, Archis, Brinjac Engineering Inc.)
331	3	9	18	9	44	In the case of whole Japan, soil erosion and yields are exponentially increased depending on extreme rainfall according to reservoir deposition data (Ono et al., Distributed specific sediment yield estimations in Japan attributed to extreme-rainfall-induced slope failures under a changing climate, Hydrology and Earth System Science, Vol.15, pp.197-207, 2011) (Kazama, So, Tohoku University)
332	3	9	21	9	23	Sentence appears to contradict itself with decrease and increase. Possibly the word increase in line 22 should be replaced with decrease? Otherwise please explain this increase in the context of decreasing total sediment. (AUSTRALIA)
333	3	9	25	9	32	A discussion of sublimation vs melting may be important to add here. Sublimation, for instance, is a largely impossible factor to model at large spatial scales in any meaningful way, but there is some evidence that sublimation is driving significant losses in both glaciers and snowpack globally, especially in tropical, subtropical, and temperate frozen resources. Kehrwald, Thompson et al., Geophysical Research, 2008; and Thompson et al. 2011, Annals of Glaciology, are both quite relevant. The role of sublimation has also been posited by people like Jeff McDonald and Pat Mulroy in North American snowpack as a recent trend. The research around sublimation is limited, but we cannot yet rule out at the mixed data around "missing" floods from glacial melting is a result of increased sublimation processes. If this is true, then the droughts predicted to come after glacial melts may come quite soon. My read is that the data is suggestive but has not been systematically explored to date. (Matthews, John, Conservation International)
334	3	9	26	0	27	Please refer to the general comment above: "Increase in glacial degraded runoff component" and "glacial discharge" or "glacier river discharge" are not interchangeable (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
335	3	9	28	9	31	The references provided do not support the result that the sediments decreased. Glacier areas have shrunk about 2-10% is not exact. The references supported my view include: \nDing Yongjian, Liu Shiyin, Li Jing, et al. 2006. The retreat of glaciers in response to recent climate warming in western China. Annals of Glaciology, 43, 97-105; \nRen Jiawen et al. 2006. Glacier variation and climate change in the central Himalayas over the past few decades. Annals of Glaciology, 43, 218-222. \n(wang, chunfeng, State Forestry Administration, China)
336	3	9	28	9	32	The whole sentence is about glacier, I suggest it should be moved to para 3.2.2, which is about the assessment of glacier. (wang, chunfeng, State Forestry Administration, China)
337	3	9	34	0	39	Suggest including more explanation about why discussion of landslides is included in this chapter on water (e.g., more intense precipitation due to climate change, relevance to water quality, etc?). (CANADA)

#	Ch	From Page	From Line	To Page	To Line	Comment
338	3	9	34	9	44	Quantitative evidence exists in the Alps that the frequency of large rock avalanches is increasing due to warming-induced glacier debuitressing and permafrost degradation (Fischer, L., Purves, S.R., Huggel, C., Noetzli, J., Haeberli, W., (2012): On the influence of\ntopographic, geological and cryospheric factors on rock avalanches and rockfalls in high-mountain areas. Natural Hazards Earth System 12, 241–254. http://dx.doi.org/10.5194/nhess-12-241-2012). This development is especially critical in connection with the formation of new lakes and the growing probability of impact waves from rock/ice avalanches into new lakes (Haeberli, W. (2013): Mountain permafrost — research frontiers and a special long-term challenge. Cold Regions Science and Technology. http://dx.doi.org/10.1016/j.coldregions.2013.02.004 ; cf. also Carey, M., Huggel, C., Bury, J., Portocarrero, C. and Haeberli, W. (2012): An integrated socio-environmental framework for glacier hazard management and climate change adaptation: lessons from Lake 513, Cordillera Blanca, Peru. Climatic Change112, 3, 733-767). Concerning landslides, the climate influence may well predominate in cold mountains. The statement on lines 43/44 should therefore be adjusted to something like " ... with the exception of cold high-mountain regions human impacts may be ...". Correct references should be given to the high-mountain aspect (cf. also Gruber, S., and Haeberli, W. (2007): Permafrost in steep bedrock slopes and its temperature-related destabilization following climate change. Journal of Geophysical Research, 112, F02S18; doi:10.1029/2006JF000547). (Haeberli, Wilfried, University of Zurich)
339	3	9	41	9	44	this sentence is an example of what stated in the previous comment (ITALY)
340	3	9	41	9	49	It would be preferable to also provide summary terms for agreement for the statements. A line-of-sight reference is also needed for the statement on lines 49-50 in order to draft to the reader to the source of the finding. (Mach, Katharine, IPCC WGII TSU)
341	3	9	43	9	44	More precise wording is required - change "the human impacts" to "local human impacts", and insert "global anthropogenic" before "climate change." (Fleming, Sean, Meteorological Service of Canada)
342	3	9	47	10	50	According to the information presented of vulnerability related to extreme hydrological events and their impacts on the natural and built, is that in Chile, the National Irrigation Strategy envisages the construction of dual-purpose infrastructure, which is able on the one hand, to control floods caused by the increase in the intensity of rainfall, and secondly, to store this water in times of surplus for use in times of shortage (CHILE)
343	3	9	49	9	50	This statement says that limited evidence leads to low confidence, but that logic isn't applied in numerous preceding sections where observed changes with limited evidence were also associated with medium to high confidence (e.g., p. 3 line 1, p. 8 lines 25-26). The relationship between level of evidence and level of confidence needs to be made consistent across impacts discussions. Also, the start of the chapter should include summary descriptions of what is meant by agreement, confidence and evidence, and how they relate; or, it should reference the some other section of AR5 that includes this explanation. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
344	3	9	49	10	16	It says that there is a low confidence due to limited evidence that CC has affected the frequency and magnitude of floods at global scale. I would suggest to include the reference of Llasat et al, (2005) showing that no trend on catastrophic floods has been produced in Catalonia since 14th century, but an increase in extraordinary floods have been produced in coastal catchments, mainly produced as a consequence of changes in vulnerability and exposure (see Barnolas and Llasat, 2007 or Llasat et al, 2010). This trend has been also found in other Mediterranean catchments (i.e. Llasat et al, 2013). References: Llasat, M.C., M. Barriendos, Barrera, A., and Rigo, T., 2005: Floods in Catalonia (NE Spain) since the 14th century. Climatological and meteorological aspects from historical documentary sources and old instrumental records. Journal of Hydrology. Applications of palaeoflood hydrology and historical data in flood risk analysis, 313, 32-47; Barnolas, M. and M.C. Llasat, 2007: A flood geodatabase and its climatological applications: the case of Catalonia for the last century. Natural Hazards and Earth System Sciences, 7, 271-281; Llasat, M. C., Llasat-Botija, M., Petrucci, O., Pasqua, A. A., Rosselló, J., Vinet, F., Boissier, L., 2013. Towards a database on societal impact of Mediterranean floods in the framework of the HYMEX project. Nat. Hazards Earth Syst. Sci., 13, 1–14, 2013. www.nat-hazards-earth-syst-sci.net/13/1/2013/ doi:10.5194/nhess-13-1-2013; Llasat, M.C., Llasat-Botija, M., Rodríguez, A., Lindbergh, S.: Flash floods in Catalonia: a recurrent situation. Advances in Geosciences, 26, 105-111, 2010. (Llasat, Maria-Carmen, University of Barcelona)
345	3	9	52	9	54	We recommend that authors replace 'suggests an increase likelihood of' with 'should increase the risk for' to read "However, recent detection of changes in extreme precipitation and discharge trends (at some catchments) should increase the risk for flooding at regional scales (medium confidence). (UNITED STATES OF AMERICA)
346	3	10	3	10	4	In the phrase "There is no strong evidence for trends in flooding in the USA (Hirsch and Ryberg, 2012)..." the adjective "strong" is not necessary. In addition the work by Lins and Cohn (2011; already in the reference list) should be added here.\n (Koutsoyiannis, Demetris, National Technical University of Athens)
347	3	10	4	10	16	Suggest citing Dahlke et al. (2012) in this passage - has important implications for flood trends in Nordic countries. The reference is Dahlke HE and others (2012), Contrasting trends in hydrologic extremes for two sub-arctic catchments in northern Sweden: does glacier melt matter? Hydrology and Earth System Science, 16:2123-2141. (Fleming, Sean, Meteorological Service of Canada)
348	3	10	6	10	44	For many statements in these paragraphs, it would be preferable to further specify the relevant time frame for the observed changes, more so than done already. (Mach, Katharine, IPCC WGII TSU)
349	3	10	8	10	8	The reference to Renard et al. 2008 is not really relevant. Renard et al. (2008) found a decreasing trend in low, high and mean flows (i.e. magnitude). The flood frequency was not analyzed. (Gascoin, Simon, CNRS)
350	3	10	8	10	8	"..Pyrenees...". Where is it? (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
351	3	10	13	10	16	I don't understand how "no compelling evidence" is supported by the citation of two studies that sound like they provide compelling evidence. (However, "significant" is a word that needs more specifics: by what measure? what kind of persistence is assumed in the null hypothesis?) (Milly, Christopher, U.S. Geological Survey)
352	3	10	14	0	0	Suggest indicating that the results for Cunderlik and Ouarda (2009) and Burn et al (2010) are for Canada, otherwise the region is not clear. (CANADA)

#	Ch	From Page	From Line	To Page	To Line	Comment
353	3	10	17	10	17	I reiterate my earlier comment on Hurst. I strongly insist that mentioning the Hurst-Kolmogorov phenomenon (long-term persistence) in the Freshwater Chapter is absolutely necessary and relevant. If hydrologists fail to refer to it, how can we expect from climatologists and scientists from other disciplines to mention it in other chapters? I suggest to refer to it by adding the following paragraph: "It should be mentioned that many of the trend analyses in the literature are based on classical statistical tests that are based on the assumption of time independence for the tested process. However, the pioneering work by Hurst (1951) has shown that hydrological and other geophysical processes are not independent in time but, on the contrary, are characterized by long-range dependence, also known as long-term persistence. The Hurst behaviour is a prominent characteristic of climate (Markonis and Koutsoyiannis, 2013; Koutsoyiannis, 2013). If this behaviour is accounted for, many of the trends rendered as significant by classical statistical tests become insignificant (Cohn and Lins, 2005)." References to be added Cohn, T. A., and H. F. Lins, Nature's style: Naturally trendy, Geophysical Research Letters, 32 (23), doi:10.1029/2005GL024476, 2005. Hurst, H. E., Long term storage capacities of reservoirs, Trans. Am. Soc. Civil Engrs., 116, 776-808, 1951. Koutsoyiannis, D., Hydrology and Change, Hydrological Sciences Journal, doi: 10.1080/02626667.2013.804626, 2013. Markonis, Y., and D. Koutsoyiannis, Climatic variability over time scales spanning nine orders of magnitude: Connecting Milankovitch cycles with Hurst–Kolmogorov dynamics, Surveys in Geophysics, 34 (2), 181–207, 2013. (Koutsoyiannis, Demetris, National Technical University of Athens)
354	3	10	20	10	20	Unqualified generalizations can be taken out of context. E.g., page 10 line 20 "It is very likely..." While true in context, if this sentence is removed it could have much broader implications. Suggest, in cases which potentially far reaching conclusions could be drawn if the sentence is takeout of context, that a clause is added to anchor it in the data source, or the specific location of the observation. (UNITED STATES OF AMERICA)
355	3	10	20	10	21	Is this referred only to Germany? (ITALY)
356	3	10	23	10	32	When insured losses due to floods are adjusted considering the premiums paid by customers and the total value of dwellings per year, the adjusted data reveals no significant trend over the period 1971–2008 and confirms that at this juncture, societal influences remain the prime factors driving insured and economic losses from natural disasters (see Barredo et al (2012)). Reference: Barredo, J.I., D. Saurí, and M. C. Llasat, 2012. Assessing trends in insured losses from floods in Spain 1971–2008. Nat. Hazards Earth Syst. Sci., 12, 1723–1729, 2012. www.nat-hazards-earth-syst-sci.net/12/1723/2012/ doi:10.5194/nhess-12-1723-2012 (Llasat, Maria-Carmen, University of Barcelona)
357	3	10	23	10	32	Increasing exposure etc. have potentially been offset by an improvement in warning systems longer lead times) and better flood protection measures. It may be worth emphasising better that climate is only one factor in a complex, multi-factor system. (Dankers, Rutger, Met Office Hadley Centre)
358	3	10	31	10	31	The word 'Korea' need to check up whether it is only South Korea or the Republic of Korea. (REPUBLIC OF KOREA)
359	3	10	34	10	46	The discussion on drought indexes considers only PDSI and CDD. The WMO recommendation is to consider also SPI - which will help compare the conclusions made with other studies. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
360	3	10	34	10	46	The CDD index seems to be the one that shows the major agreement on its present and future increase in Europe (see as exemple Turco and Llasat, 2011). Reference: Turco, M. y M. C. Llasat, 2011. Trends in indices of daily precipitation extremes in Catalonia (NE Spain), 1951–2003. Nat. Hazards Earth Syst. Sci., 11, 3213–3226, doi:10.5194/nhess-11-3213-2011. (Llasat, Maria-Carmen, University of Barcelona)
361	3	10	36	10	37	A box explaining exactly what the PDSI, CDD AND SMA are and how they are calculated would be useful - or at least references to such explanations. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
362	3	10	37	10	39	The authors should consider deleting this entire sentence "The AR4 (Trenberth et al., 2007) reported that the global extent of very dry areas (PDSI -3.0) more than doubled since the 1970s, and that droughts have increased since then particularly in the tropics and sub-tropics (Dai et al., 2004)." The 2013 AR5 results are more current and Dai has redone this analysis multiple times since 2004. (UNITED STATES OF AMERICA)
363	3	10	39	10	41	Milly and Dunne (2011, On the hydrologic adjustment of climate-model projections: the potential pitfall of potential evaporation, Earth Interactions, v 15, no 1, p. 1-14) present evidence that empirical, temperature-based estimates of PET (as used, e.g., in standard PDSI) grossly overestimate changes in PET associated with anthropogenic climate change, with consequent negative bias in runoff projections. (Milly, Christopher, U.S. Geological Survey)
364	3	10	44	10	46	I question this attribution, but I have not read the citation recently. What physical mechanism was used to justify attribution to temperature? Temperature change does not cause evaporation change. Evaporation is driven by energy availability, and temperature is a result of both energy availability (positive influence) and actual ET (negative influence). (Milly, Christopher, U.S. Geological Survey)
365	3	11	0	12	0	General comment - Section 3.3:\nIt is necessary to highlight that the various climatic and non-climatic drivers may interact with each other to exacerbate or alleviate impacts. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
366	3	11	1	12	0	It is necessary to highlight that the various climatic and non-climatic drivers may interact with each other to exacerbate or alleviate impacts. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
367	3	11	1	12	16	Section 3.3.1: The amount of material in here on Climatic Drivers could be reconsidered, as this is essentially material that is assessed in the WGI contribution to AR5 and the risk of overlap and inconsistency should be avoided to the extent possible. Some WGI Ch12 ES statements seem to have been reworded and not all of them are consistent with WGI: "Arctic is warming most rapidly" (WG1) becomes "Warming is greatest over the Arctic"; "It is very likely that Northern Hemisphere snow cover will reduce..." (WG1) becomes "Less precipitation falls as snow and the extent and duration of snow cover decrease" without NH focus etc. Please revisit WGI type statements and ensure consistency (Plattner, Gian-Kasper, IPCC WGI TSU)
368	3	11	5	11	5	Potential evaporation or potential evapotranspiration ? (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
369	3	11	5	11	5	Principal "climatic drivers" are vapor content and temperature -- rather than precipitation and evapotranspiration (and snowmelt) processes -- which are responses to humidity and temperature levels. These responses should themselves be considered as the principal water inputs and outputs to the hydrologic system from the climate system. These drivers also affect snowmelt and related processes that serve to redistribute water across the terrestrial regime. (UNITED STATES OF AMERICA)
370	3	11	5	11	24	The context should provide information about effect of ocean circulation and ocean surface temperature changes if any, because it is strongly influenced to climate pattern in land. (Kazama, So, Tohoku University)
371	3	11	5	11	24	I don't understand why T and actual E are mentioned after saying that P and PET are the main climatic drivers. Background assumptions about what controls what are apparently present but not being stated. (Milly, Christopher, U.S. Geological Survey)
372	3	11	9	0	10	This sentence is confusing; suggest revising. (CANADA)
373	3	11	15	0	0	Did authors mean "Evaluation" instead of "Evolution" (Ambulkar, Archis, Brinjac Engineering Inc.)
374	3	11	15	11	15	It is not clear what is meant by 'the evolution of climate drivers' in this context - evolution over what time period? The paragraph is phrased in the negative - could this be balanced by a statement on what we do understand about how climate drivers are changing? (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
375	3	11	15	11	24	Is this section on climate drivers and variability consistent with how climate drivers are defined in the Technical Summary? Commenter believes that internal ocean or coupled ocean-atmosphere variability has greater influence on climate variability than internal atmospheric variability. (UNITED STATES OF AMERICA)
376	3	11	16	11	17	The second major issue is: "...inaccurate modeling of the atmospheric response to external forcings (page 11, Line 16-17)". I do not agree with this comment. Can authors provide specific references for this? At its minimum expectations, climate models are expected to model the response of external forcings e.g. green house gas emissions. There could be (in fact there are) uncertainties in modeling the response of external forcings e.g. land use land cover change (Pitman et al. 2009; Kumar et al. 2013d). However, saying '...inaccurate modeling ...' is like questioning the basic foundations of climate modeling. I have raised this issue in the FOD too, but it has not been addressed satisfactory in the SOD. I would suggest following revision in this respect: " ...uncertainties in modeling of atmospheric response to external forcings". ***** continued (5 of 6) (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
377	3	11	16	11	17	Reference: \nPitman, A. J., et al. (2009), Uncertainties in climate responses to past land cover change: First results from the LUCID intercomparison study, Geophys. Res. Lett., 36, L14814, doi:10.1029/2009GL039076\n\nKumar S., P. A. Dirmeyer, V. Merwade, T. DelSole, J. M. Adams, and D. Niyogi, 2013(d): Land Use/Cover Change Impacts in CMIP5 Climate Simulations –A New Methodology and 21st Century Challenges. Journal of Geophysical Research (Atmospheres), doi:10.1002/jgrd.50463, in press. *****continued (6 of 6) (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
378	3	11	17	11	18	Correct the sentence "The water balance of the surface excludes aquifers and the atmosphere, and when there are no substantial lakes, wetlands or glaciers the annual change of storage in the soil is often assumed to be zero" by "The water balance of the surface excludes aquifers (except in their direct contribution to the river flow) and the atmosphere, and when there are no substantial lakes, wetlands or glaciers the change of storage in the soil at the annual scale or at a larger period of time is often assumed to be zero". (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
379	3	11	18	11	20	This sentence refers to CMIP5 projections, but figure 3-4 shows results from a study informed by CMIP3. The authors should reconcile. (UNITED STATES OF AMERICA)
380	3	11	19	11	19	Should "all" within "all of the uncertainty" be qualified at all--"almost all"? (Mach, Katharine, IPCC WGII TSU)
381	3	11	19	11	20	CMIP5: the mentioned Fig. 3.4 at page 71 (as also reported in captions, line 29) reports CMIP3 and not CMIP5 results (Cassardo, Claudio, University of Torino)
382	3	11	20	11	23	The negative phrasing of this sentence and multiple time periods and sources of uncertainty make it hard to interpret. Suggest the sentence is broken up to gain clarity. (AUSTRALIA)
383	3	11	29	0	0	Term "GCM" needs to be defined here, as it is used for first time in this chapter. (Ambulkar, Archis, Brinjac Engineering Inc.)
384	3	11	32	11	32	CMIP5. It should be spelled out (Acronyms are sometime frustrating for the reader) (Athanasios Loukas, Civil Engineering Department, University of Thessaly, Greece) (GREECE)
385	3	11	32	11	32	Suggest authors replace 'of' with 'projected changes in' to read "CMIP5 simulations projected changes in the water cycle." (UNITED STATES OF AMERICA)
386	3	11	32	11	54	Given the statement on lines 21-24, is it possible to indicate how any of these projected changes vary with level of climate change, general time frame in the future, etc.? (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
387	3	11	33	11	37	There are further non-structural measures to water management, including water allocation, economic and regulatory instruments, water efficiency improvements etc. Measures aimed at water demand management are completely ignored in this part of the text. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
388	3	11	35	11	35	Suggest authors replace 'increases' with 'is projected to increase.' (UNITED STATES OF AMERICA)
389	3	11	36	11	36	Suggest authors replace 'is' with 'is projected to be.' (UNITED STATES OF AMERICA)
390	3	11	36	11	36	Is "zonally" the correct term to use here? The preceding content seems to imply meridional (N-S) rather than zonal (E-W) variability... (Fleming, Sean, Meteorological Service of Canada)
391	3	11	38	11	38	Suggest authors replace 'falls' with 'is projected to fall.' (UNITED STATES OF AMERICA)
392	3	11	38	11	40	The author might wish to add here that in many cold (high-latitude and/or high-altitude) regions, winter temperatures may be sufficiently low overall that the impacts of rising air temperatures on rain:snow ratios may be hydrologically significant only in the shoulder seasons of autumn and spring. (Fleming, Sean, Meteorological Service of Canada)
393	3	11	41	11	41	Suggest authors replace 'become' with 'are projected to become.' (UNITED STATES OF AMERICA)
394	3	11	44	11	44	Suggest authors replace 'tends' with 'will tend.' (UNITED STATES OF AMERICA)
395	3	11	47	11	48	Could some regions where projections lie within the range of natural variability be given? There is also no reference given for this statement, but there needs to be. (AUSTRALIA)
396	3	11	51	11	51	Suggest authors replace 'increases' with 'is projected to increase.' (UNITED STATES OF AMERICA)
397	3	11	51	11	54	I do not see any mention to wilting point. I suppose soil moisture will exceed (in negative) for a larger amount of time the wilting point (Cassardo, Claudio, University of Torino)
398	3	11	51	11	54	Increase of E in concert with P leads to decrease in soil moisture? I don't follow the physics. Increase in P generally leads to increase in E and soil moisture. Different processes are apparently being mixed without sufficient explanation in this brief pair of statements. (Milly, Christopher, U.S. Geological Survey)
399	3	11	53	0	0	Suggest clarifying what is meant by "southern North America (e.g., is this referring to Mexico or to the interior of North America?). (CANADA)
400	3	12	0	12	0	General comment - Section 3.3.2\nMore examples (other than agricultural-related) of non-climatic drivers needed, e.g. socio-economic ones. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
401	3	12	1	12	0	More examples (other than agricultural-related) of non-climatic drivers needed, e.g. socio-economic ones. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
402	3	12	14	12	16	Insert reference (this paper is now accepted in HESS): . H. Taylor, E. Burke, L. McColl, P. Falloon, G. R. Harris, and D. McNeall, 2012.Contributions to uncertainty in projections of future drought under climate change scenarios. Hydrology and Earth System Sciences Discussions, 9, 12613?12653, doi:10.5194/hessd-9-12613-2012. (Falloon, Peter, Met Office Hadley Centre)
403	3	12	14	12	16	Mediterranean and central Europe may experience longer and more frequent droughts. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
404	3	12	19	12	19	Replace evaporation by evapotranspiration (Portela, Maria Manuela, Instituto Superior Tecnico (IST))

#	Ch	From Page	From Line	To Page	To Line	Comment
405	3	12	19	12	37	Section 3.3.2 on "non-climatic drivers" is very limited and ignores aspects of current water management practices that could increase future vulnerability, such as the depletion of groundwater reserves, environmental damage that can impact on water bodies, etc. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
406	3	12	21	12	36	It seems important to specifically mention other forms of land use change, such as forestry and urbanization. The latter in particular has absolutely huge implications for both flooding and drought. (Fleming, Sean, Meteorological Service of Canada)
407	3	12	32	12	36	I suggest to revise the affirmation that "irrigation accounts for about 90% of global water consumption" because not is the situation of Latin America and the Caribbean (neither in Cuba) that is about 70-75%, neither North America, neither Europe. However I agree with second part of the line where affirm that: "severely impacts freshwater availability for humans and ecosystems" (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
408	3	12	32	12	36	The number most frequently used for the percentage of freshwater withdrawn for irrigation globally is 70% (FAO). Of that amount, 90 percent is consumptive usage (FAO) (i.e. not available for reuse). Authors should use the FAO language so as not to exaggerate for lay readers the amount of freshwater absorbed for irrigation. (UNITED STATES OF AMERICA)
409	3	12	33	12	34	regarding these percentages, I suggest also, on Hydrol. Earth Syst. Sci., 14, 1863–1880, 2010, the paper "Groundwater use for irrigation – a global inventory", by Siebert et al. (available here http://www.fao.org/docrep/013/al816e/al816e00.pdf) (Cassardo, Claudio, University of Torino)
410	3	12	34	12	35	Though having various facets, ultimately, anthropogenic global climate change is a direct result of human population growth, not something apart from it - so please rephrase this passage. This is obvious from the SRES scenarios, for instance. Also, for an interesting recent paper on this, worthy of citation, see Murtaugh PA, Schlax MG. (2009), Reproduction and the carbon legacies of individuals, Global Environmental Change, 19:14-20. (Fleming, Sean, Meteorological Service of Canada)
411	3	12	36	12	36	In Taylor et al (now 2013, not 2012) land use change (largely agriculture) may indirectly influence terrestrial hydrology more than direct climate change. This suggests that aspects of climate change that influence land use change are fairly important in this calculus (e.g., Lobell and Field, 2007; Climatic Change, 81(2),187). (UNITED STATES OF AMERICA)
412	3	12	39	20	26	Section 3.4: WGI references are still rare, please include the corresponding WGI links in your assessment; Section 3.4.2: WGI is not cited correctly, i.e., evapotranspiration changes are not very likely according to Ch12. Section 3.4.4: Please refer to the WGI glacier assessment, e.g., swap the specific Church et al ref for Glacier Mass Loss with the corresponding WGI reference (Plattner, Gian-Kasper. IPCC WGI TSU)
413	3	12	41	12	47	This idea could be developed further. According to e.g. table 4.1 in chapter 4 we are not going to have a situation with future climate but current land use. Though this is assumed to be the reference state in several modelling studies, and thus scenarios are copared to 'unrealistic' reference. Maybe better ideas are welcome? (Rankinen, Katri, Finnish Environment Institute)

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414	3	12	49	12	51	Future change in flood exposure by Hirabayashi, Y. et al. (2013) (ref. in the page 50, Nature Climate Change, in print) would be suitable to be included in Table 3-2. Two ways of presentation, RCP scenario-based or degree of global warming (GW) can be provided (see below). Other numbers (number of exposure in millions, in addition to % to global population) can be provided, if required. \n(1) [Type of hydrological change or impact] Flood exposure, global scale, [Description of indicator] Number of people annually exposed to a flood corresponding to 100-year flood discharge in 20C (1971-2000) with population fixed at the level in the year 2005, in % of world population in 2005 (1971-2000 for historical and 2071-2100 for future, mean and range of multi models), [Hyd. change or impact in different emissions scenarios or different degrees of global warming] historical (11GCM): 0.1% (0.04-0.16%), RCP2.6 (8 GCMs): 0.4% (0.2-0.5%), RCP4.5 (11 GCMs): 0.6% (0.4-1.0%), RCP6.0 (5GCMs): 0.7% (0.3-1.1%), RCP8.5 (11 GCMs): 1.2% (0.6-1.7%). \n(2) [Type of hydrological change or impact] Flood exposure, global scale, [Description of indicator] Number of people annually exposed to a flood corresponding to 100-year flood discharge in 20C (1971-2000) with population fixed at the level in the year 2005, in % of world population in 2005 (mean and range of multi models and scenarios), [Hyd. change or impact in different emissions scenarios or different degrees of global warming] GW, no change in population (fixed at the level in the year 2005): 1?: 0.3% (0.2-0.5%), 2?: 0.4% (0.3-0.6%), 4?: 1.0% (0.7-1.7%). (Hirabayashi, Yukiko, The University of Tokyo)
415	3	13	0	0	0	Explaining modelling technologies is very good idea, and probably benefits policy makers very much (Rankinen, Katri, Finnish Environment Institute)
416	3	13	1	14	7	This point 3.4.1 need a conclusion of Lead Authors after are shown different Methodological Developments. (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
417	3	13	8	13	14	A new publication in Hydrological Processes addressed a hydrological model(TOPMODEL) based on the use of seven climate projected scenarios. Talking about given the present several scenarios, it illustrated that weighting the scenarios was not more reasonable and acceptable than ensemble results,which argued the idea of "probability distribution of future impacts".It could be addressed as a opposing view in LINE 14.It could be changed as "to give to each scenario(Brekke et al., 2009b;...)...., while other sutdies argued that given the present situation weighting the scenarios was not more reasonable and acceptable than ensemble results.(Liu et al,2013) " . Liu, Y., Zhang, J., Wang, G., Liu, J., He, R., Wang, H., Liu, C. and Jin, J., 2013: Assessing the effect of climate natural variability in water resources evaluation impacted by climate change. Hydrological Processes, 27(7): 1061–1071. doi: 10.1002/hyp.9251 (Wang, Guoqing, Nanjing Hydraulic Research Institute)
418	3	13	11	13	11	Insert references (thie first paper is now accepted in HESS): H. Taylor, E. Burke, L. McColl, P. Falloon, G. R. Harris, and D. McNeall, 2012.Contributions to uncertainty in projections of future drought under climate change scenarios. Hydrology and Earth System Sciences Discussions, 9, 12613?12653, doi:10.5194/hessd-9-12613-2012 ; Burke, E. J.: Understanding the sensitivity of different drought metrics to the drivers of drought under increased atmospheric CO2, J. Hydrometeorol., 12, 1378–1394, doi:10.1175/2011JHM1386.1, 2011 ; Burke, E. J. and Brown, S. J.: Evaluating uncertainties in the projection of future drought, J. Hydrometeorol., 9, 292–299, doi:10.1175/2007JHM929.1, 2008. (Falloon, Peter, Met Office Hadley Centre)
419	3	13	11	13	14	Two other examples of probabilistic hydrological impact assessments which could be mentioned here have been provided by Weiss (2011, doi:10.5194/nhess-11-2163-2011) and Wetterhall et al. (2011, doi:10.5194/nhess-11-2295-2011). An example for impacts on permafrost (also covered in this chapter) has been presented by Fronzek et al. (2011, doi:10.5194/nhess-11-2981-2011). (Fronzek, Stefan, Finnish Environment Institute)
420	3	13	18	13	18	delta method' may not be clear to all (ITALY)

#	Ch	From Page	From Line	To Page	To Line	Comment
421	3	13	18	13	34	Downscaling discussion is a good start, but currently remains mediocre. What about dynamical downscaling (RCMs)? Or more sophisticated statistical downscaling approaches, like TreeGen for instance? Or intermediate-complexity physically oriented approaches, like simplified orographic precipitation models, say? All of these have been extensively and productively used for assessing the hydrologic impacts of projected future climatic changes. (Fleming, Sean, Meteorological Service of Canada)
422	3	13	20	13	23	The downscaling uncertainty has also been recently highlighted by Lafaysse et al. (2013) in a study using several stochastic statistical downscaling methods driven by ENSEMBLES GCMs over a catchment located in the Southern French Alps. Their study fully supports the statement that downscaling uncertainty can be as large as GCM uncertainty.\n- Lafaysse, M., Hingray, B., Terray, L., Mezghani, A., and Gailhard, J. (2013) Sources of uncertainty in future climate and hydrological projections: the Alpine Durance basin. Water Resources Research, accepted. (Vidal, Jean-Philippe, Irstea)
423	3	13	22	13	22	Another key reference discussing different bias correction methods is: Hawkins, Osborne, Ho & Challinor, 2013, 'Calibration and bias correction of climate projections for crop modelling: an idealised case study over Europe', Agric. For. Meteorol., 170, 19-31. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
424	3	13	27	13	29	This sentence indicates the shortage of the delta method. Otherwise how much impacts are there on runoff, evapotranspiration, and soil moisture caused by the changes in variability of climatic variables? One paper published in the Hydrological Processes, entitled "Sensitivity of hydrological variables to climate change in the Haihe River basin, China" (Bao et al., 2012) investigated the impacts of the inter-annual variability of precipitation on hydrological variables, and could be added to this part. A sentence could be added to this part is "Besides the change of annual mean temperature, there is a significant impact of inter-annual distribution of precipitation change on runoff. Further more the sensitivity of runoff to the inter-annual distribution of precipitation is higher than it to annual mean temperature (Bao et al., 2012)." [1] Bao Z., Zhang J., Liu J., Wang G., Yan X., Wang X., Zhang L., Sensitivity of hydrological variables to climate change in the Haihe River basin, China, Hydrological Processes, 2012, 26(15): 2294-2306, doi: 10.1002/hyp.8348. (Wang, Guoqing, Nanjing Hydraulic Research Institute)
425	3	13	29	13	30	...can cause discrepancy... Better to say it adds uncertainty. Relevant references: Hagemann et al. 2011 (http://dx.doi.org/10.1175/2011jhm1336.1) and Ehret et al., 2012 (doi:10.5194/hess-16-3391-2012). It has been argued that bias correction hides rather than reduces the uncertainties, compared to uncorrected climate simulations (Ehret et al., 2012). To what extent bias correction affects the impact *projections* has not been explored in great detail. (Dankers, Rutger, Met Office Hadley Centre)
426	3	13	30	13	30	After "(Watanabe et al., 2012)", the following sentence could be added: "Hagemann et al. [2011] analyzed the impact of a state-of-the-art statistical bias correction method on the hydrological changes obtained from two hydrological models and three GCMs, finding that the introduced level of uncertainty of the correction could potentially be comparable to the uncertainty related to the choice of the GCM. Nonetheless there is still ongoing research on the reduction of uncertainty of statistical bias correction techniques like the piecewise correction presented in Grillakis et al. [2013]."\nHagemann, S., C. Chen, J. O. Haerter, J. Heinke, D. Gerten, and C. Piani (2011), Impact of a statistical bias correction on the projected hydrological changes obtained from three GCMs and two hydrology models, J. Hydrometeorol., 12, 556–578, doi:10.1175/2011JHM1336.1.\nGrillakis, M. G., Koutroulis, A. G., Tsanis I.K. Multi-segment statistical bias correction of daily GCM precipitation output. Journal of Geophysical Research (2013), 118, 1–13, doi:10.1002/jgrd.50323. (Aristeidis Koutroulis, Water Resources Management & Coastal Engineering Laboratory, Technical University of Crete, Greece) (GREECE)

#	Ch	From Page	From Line	To Page	To Line	Comment
427	3	13	30	13	30	Insert references on bias correction in hydrology: Sperna Weiland, F. C., van Beek, L. P. H., Kwadijk, J. C. J., and Bierkens, M. F. P.: The ability of a GCM-forced hydrological model to reproduce global discharge variability, Hydrol. Earth Syst. Sci., 14, 1595-1621, doi:10.5194/hess-14-1595-2010, 2010; Ehret, U., Zehe, E., Wulfmeyer, V., Warrach-Sagi, K., and Liebert, J.: HESS Opinions "Should we apply bias correction to global and regional climate model data?", Hydrol. Earth Syst. Sci., 16, 3391-3404, doi:10.5194/hess-16-3391-2012, 2012; Hagemann, Stefan, Cui Chen, Jan O. Haerter, Jens Heinke, Dieter Gerten, Claudio Piani, 2011: Impact of a Statistical Bias Correction on the Projected Hydrological Changes Obtained from Three GCMs and Two Hydrology Models. J. Hydrometeor, 12, 556–578.doi: http://dx.doi.org/10.1175/2011JHM1336.1 (Falloon, Peter, Met Office Hadley Centre)
428	3	13	30	13	31	The horizontal resolution of the GCMs used in the papers cited here is rather coarse. Nakaegawa et al. (2013) used a 20-km mesh AGCM for river discharge projections and used a 60-km mesh AGCM forced with four different projected SSTs to quantify the uncertainties. The projections by the 60-km mesh AGCM with the quantified uncertainties are used as regional projections for all the regions in the IPCC WG1 AR5 SOD. To ensure consistency between WG I and WG II is important in AR5, Nakaegawa et al. (2013) shown below should be cited here. Besides, Nakaegawa et al. (2013) should be taken into consideration in subsection 3.4.5. Nakaegawa, T., A. Kitoh, and M. Hosaka. 2013: Discharge of major global rivers in the late 21st century climate projected with the high horizontal resolution MRI-AGCMs -overview-. Hydrological Processes. 27. DOI: 10.1002/hyp.9831 (JAPAN)
429	3	13	31	0	0	How high horizontal resolution does these global climate models have? These models seemed to have coarser horizontal resolution than a state-of-art model.Nakaegawa et al. (2013) used a 20-km mesh AGCM for river discharge projections and used a 60-km mesh AGCM forced with four different projected SSTs to quantify the unceratinties. The projections by the 60-km mesh AGCM with the quantified uncertainties are used as regional projections for all the regions in AR5 WG I.. A liasion between WG I and WG II is an important aspect in AR5, the following article may be cited here: Nakaegawa, T., A. Kitoh, M. Hosaka. 2013: Discharge of major global rivers in the late 21st century climate projected with the high horizontal resolution MRI-AGCMs -overview-. Hydrological Processes. 27. DOI: 10.1002/hyp.9831 (Nakaegawa, Toshiyuki, Meteorological Research Institute)
430	3	13	31	13	31	Include Nakaegawa et al., 2013 as a cite after Hirabashi et al, 2008. The corresponding reference is: T. Nakaegawa, A. Kitoh, M. Hosaka. 2013: Discharge of major global rivers in the late 21st century climate projected with the high horizontal resolution MRI-AGCMs-overview. Hydrological Processes. 27 DOI:10.1002/hyp. 9831. (Fábrega, José, Universidad Tecnológica de Panamá)
431	3	13	34	13	34	I would recommend replacing the sentence "however this has not yet been systematically evaluated" with "Comparisons of GCM-simulated riverflow with observations suggests reasonable skill at annual timescales but less confidence in monthly predictions (Falloon et al. 2011), and results are strongly dependent on the quality of GCM input data and basin size (Sperna Wieland et al. 2012)." References: Falloon, P, Betts R, Wiltshire A, Dankers R, Mathison C, McNeill D, Bates P, Trigg M (2011). Validation of river flows in HadGEM1 and HadCM3 with the TRIP river flow model. Journal of Hydrometeorology,12,1157-1180. doi: 10.1175/2011JHM1388.1 ; Weiland, F. C. Sperna, L. P. H. van Beek, J. C. J. Kwadijk, M. F. P. Bierkens, 2012: On the Suitability of GCM Runoff Fields for River Discharge Modeling: A Case Study Using Model Output from HadGEM2 and ECHAM5. J. Hydrometeor, 13, 140–154. doi: http://dx.doi.org/10.1175/JHM-D-10-05011.1 (Falloon, Peter, Met Office Hadley Centre)

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432	3	13	36	13	41	In the recent publication of "Quantifying Uncertainty in Catchment-scale Runoff Modeling under Climate Change (Case of the Huaihe River, China)", it discussed the uncertainty of hydrological model uncertainty, emission scenarios, and global climate model outputs(including the downscaling techniques) in a quantitative manner, the results show for runoff the GCM uncertainty is larger than that due to emission scenarios, and after calibration, model parameter uncertainty was much smaller and in different magnitude compared with other uncertainties. It demonstrated the view of "hydrological model parameter uncertainty smaller than climate scenarios", and pointed out the climate uncertainty may be in larger magnitude than hydrological model uncertainty. It could be recommended as a supplemental view in LINE39 before"However".That is to say, after LINE36-37,"...large number of climate scenarios, and even the emission scenarios uncertainty are smaller than global climate model uncertainty, a study show that the hydrological model parameter uncertainty even smaller than them on magnitude.(Liu et al, 2012)". Liu, Y., Zhang, J., Wang, G., Liu, J., He, R., Wang, H., Liu, C. and Jin, J., 2012: Quantifying \nUncertainty in Catchment-scale Runoff Modeling under Climate Change (Case of the Huaihe \nRiver, China), Quaternary International, 282:130-136.\n (Wang, Guoqing, Nanjing Hydraulic Research Institute)
433	3	13	36	13	46	Christierson et al. (2012) showed that climate uncertainties (20-member sampled UKCP09 projections) are larger then hydrological uncertainties (2 model structures + GLUE parameters) for monthly flows in 70 UK catchments. However, the part of uncertainties due to the hydrological modelling step (2 model structures) can be much larger than those due to the GCM uncertainty (7 GCMs) for low flow characteristics over the whole of France, as shown by Chazot et al. (2013). Indeed, low flow characteristics are much more dependent on catchment-related processes and on the way they are implemented in each hydrological model structure.\n- Chazot, S., Chauveau, M., Perrin, C., Bourgin, P.-Y., Sauquet, E., Vidal, J.-P., Rouchy, N., Martin, E., David, J., Norotte, T., Maugis, P., and de Lacaze, X. (2013) What impacts of climate change on surface hydrology in France by 2070? Houille Blanche-revue Internationale De L Eau, accepted\n- Christierson, B. v., Vidal, J.-P., and Wade, S. D. (2012) Using UKCP09 probabilistic climate information for UK water resource planning. Journal of Hydrology, 424-425, 48-67. doi: 10.1016/j.jhydrol.2011.12.020 (Vidal, Jean-Philippe, Irstea)
434	3	13	36	13	46	Milly and Dunne (2011, On the hydrologic adjustment of climate-model projections: the potential pitfall of potential evaporaton, Earth Interactions, v 15, no 1, p. 1-14) have shown that the main difference in hydrology downstream of climate-model output is associated with inappropriate translation of atmopsheric input to hydrologic model inputs, not to details of how the hydrologic response is modeled. In an assessment of this type (AR5), I recommend that the authors critically review the possibility that apparent substantial effects of model uncertainty could in fact be spurious methodological artifacts. (Milly, Christopher, U.S. Geological Survey)
435	3	13	41	13	41	after "evaporation", insert "particularly the uncertain impact of CO2 on evapotranspiration (Davie et al. 2013)" and provide a link to box CC-VW (Falloon, Peter, Met Office Hadley Centre)
436	3	13	45	13	46	The sentence which starts line 45 must clarify if its content is based on scenarios or if it results from real observations. In this last case the regions to which the sentence appllies need to be identified. (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
437	3	13	53	13	54	It is not necessary to use the hydrological model to simulate future hydrologic characteristics - I suspect this has been mis-stated. (Fleming, Sean, Meteorological Service of Canada)
438	3	14	4	14	7	The sensitivity / response surface approach does require running the impact model over a much wider range of climate changes, calling into question the plausibility of the results (especially where impact models are tuned to current conditions). (Dankers, Rutger, Met Office Hadley Centre)
439	3	14	10	14	17	Global ET is dominated by oceanic ET. Why is it the focus of the ET section of a freshwater chapter? (Milly, Christopher, U.S. Geological Survey)

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440	3	14	10	14	24	Section 3.4.2 might be a good place to revisit the so-called "evaporation paradox" discussed in Section 3.2.2 - otherwise, there would appear to be an internal inconsistency in the chapter...? (Fleming, Sean, Meteorological Service of Canada)
441	3	14	12	14	13	The statement "it is projected that global evapotranspiration is very likely to increase in a warmer climate" is not supported as such by Collins et al., 2013 (WGI Chapter 12). To reference Collins et al., 2013 (WGI Chapter 12), rewrite text as: "it is projected that potential evapotranspiration over most land areas is very likely to increase in a warmer climate." (UNITED STATES OF AMERICA)
442	3	14	12	14	14	You may want to add "increase in land evaporation can become limited by the water availability" see Fig.10 in kumar et al. 2013(d). This is because increase in precipitation with warming does not follow the Clausius-Clapeyron relationship i.e. 7% increase in precipitation per 1K warming. Model simulations show much weaker response of precipitation to global warming (~ 2% increase in precipitation per K warming; see Held and Soden 2006 for details). \nReference:\nKumar S., P. A. Dirmeyer, V. Merwade, T. DelSole, J. M. Adams, and D. Niyogi, 2013(d): Land Use/Cover Change Impacts in CMIP5 Climate Simulations –A New Methodology and 21st Century Challenges. Journal of Geophysical Research (Atmospheres), doi:10.1002/jgrd.50463, in press. \nHeld, I. M., and B. J. Soden (2006). Robust response of hydrologic cycle to global warming. Journal of Climate, 19, 5686-5699. (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
443	3	14	12	14	17	In discussing how global evapotranspiration may increase under climate change, no mention is made of indirect and opposing effects such as changes in wildfire regimes or changes in the frequency and intensity of pest and diseases on vegetation water use. These, together with drought deaths, have the potential to reduce interception and transpiration from these landscapes. (AUSTRALIA)
444	3	14	12	14	24	As previous, indicate explicitly if actual or potential evaporation is considered (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
445	3	14	13	14	13	very likely as a likelihood term should be italicized. (Mach, Katharine, IPCC WGII TSU)
446	3	14	14	14	15	Many ... apparent: at which scale? Global? Regional? All? (Cassardo, Claudio, University of Torino)
447	3	14	14	14	15	radiation: I think you means "net radiation" (Cassardo, Claudio, University of Torino)
448	3	14	19	14	24	Does this paragraph mean that PET isn't a very useful metric for assessing climate change impacts on hydrology? (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
449	3	14	19	14	24	This section describes uncertainties in PET estimates as an important source of uncertainty in hydrological projections. However, no reference is made to the number of hydrological projections that use PET and whether it is indeed a good idea to do hydrological projections using PET. In many cases the use of PET may not be advisable and moreover the fact that there are no negative feedbacks in many PET models (e.g., soil water store computation) suggest that uncertainties in PET may exceed uncertainties in ET for projections. Suggest increasing discussion of methods used for ET estimates in this section. (CANADA)
450	3	14	19	14	24	Relevant missing citations are Milly and Dunne (2011, On the hydrologic adjustment of climate-model projections: the potential pitfall of potential evaporaton, Earth Interactions, v 15, no 1, p. 1-14) and Shaw and Riha (2011, Assesssing temperature-based PET equations under a changing climate in temperate, deciduous forests, Hydrol. Proc., 25, 1466-1478). (Milly, Christopher, U.S. Geological Survey)
451	3	14	22	14	22	Penman-Monteith formula: are you talking of ET or PET? (Cassardo, Claudio, University of Torino)

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452	3	14	22	14	24	it is not clear to me the meaning of the percentages. 100% refers to the difference between BC formulation and PM formula? If so, how you can talk about "smaller changes"? And, if uncertainty (with respect to data?) is just 20% to 40%, in case of a difference of 100% it may be possible to assess which method is better. Have I understood wrongly? Also, which is the reference for the percentages? (Cassardo, Claudio, University of Torino)
453	3	14	27	0	0	The permafrost paragraph could also refer to relevant section in Chapter 28. (Fronzek, Stefan, Finnish Environment Institute)
454	3	14	29	14	36	It is difficult to follow the distinction between general/regionally specific statements and discussion on soil moisture/drought in this paragraph. E.g. 'Low soil moisture episodes of 3-6 month duration doubles in extent and frequency and droughts longer than 12 months become three times more common' - Do these statements refer only to the regions specified in the first sentence? The next sentence states (presumably in relation to the statement on drought) that 'this is particularly the case where reductions in soil moisture are projected' - are these different regions to where low soil moisture doubles? The final sentence appears to be a more globally specific statement that generally monotonic increases are not statistically different from current climate. If this statement is in relation to the specific regions where soil moisture reduces, an explanation of how drought can become three times more common but not be statistically different may be needed. (AUSTRALIA)
455	3	14	38	14	38	ofnorthern -> of northern (Eliseev, Alexey V., A.M.Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences)
456	3	14	38	14	38	ofnorthern separate (Cassardo, Claudio, University of Torino)
457	3	14	38	14	38	of northern (ITALY)
458	3	14	38	14	41	in line 38, add a space between "of northern". In line 41, please check if an increase of permafrost area is really expected in scenario RCP2.6 after an initial decrease...may be due to changing landcover it could happen... (Vieira, Goncalo, University of Lisbon)
459	3	14	38	14	41	what about the "second half" of 21st century for the permafrost? (Cassardo, Claudio, University of Torino)
460	3	14	38	14	41	Would be good to briefly summarize the hydrological implications of the discussed permafrost changes, e.g., soil meltwater generation, increased aquifer storage, etc. (Fleming, Sean, Meteorological Service of Canada)
461	3	14	40	14	41	The timeframe for this projection should be specified, both in terms of the stabilization and in terms of the subsequent increase. (Mach, Katharine, IPCC WGII TSU)
462	3	14	44	0	0	The following article is cited in AR5 WG I as one of the lines of projected amount of global glaciers: Hirabayashi, Zang, i Watanabe, Koirala, and Kanae. 2013: Projection of glacier mass changes under a high-emission climate scenario using the global glacier model HYOGA2. Hydrological Research Letters. 7. 6-11. http://dx.doi.org/10.3178/hrl.7.6 (Nakaegawa, Toshiyuki, Meteorological Research Institute)
463	3	14	44	15	14	Although this is a good start, the referencing is too light in this section, as reflected in the oversimplistic content. In fact, one of the most basic messages of the passage - that "peak meltwater" is coming - is quite misleading, as in many parts of the world it has already happened. Five key references to follow up on are as follows: (i) Baraer M and others (2012), Glacier recession and water resources in Peru's Cordillera Blanca, Journal of Glaciology, 58:134-150; (ii) Stahl K and Moore RD (2006), Influence of watershed glacial coverage on summer streamflow in British Columbia, Canada. Water Resources Research, 42, doi:10.1029/2006WR005022; (iii) Stahl K and others (2008), Coupled modelling of glacier and streamflow response to future climate scenarios. Water Resources Research, 44, doi:10.1029/2007/WR005956; (iv) Moore RD and others (2009), Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality. Hydrologic Processes 23: 42-61; (v) Jost G and others (2012), Hydrology and Earth System Science, 16:849-860. (Fleming, Sean, Meteorological Service of Canada)

#	Ch	From Page	From Line	To Page	To Line	Comment
464	3	14	47	0	48	Such shifts are region specific and governed by the glacio-hydrologic regimes. It is not fair to construct it as a globally valid response. In precipitation dominant glacier regimes like monsoon dominated “Himalayan catchments” (Thayyen and Gergan, 2010), the annual peak runoff will remain in July & August irrespective of the change in glacier meltwater flow regime. This is in fact being stated at page-15 Line 49 and it may be appropriate to reflect in the global synthesis rather than regional analysis (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
465	3	14	48	14	48	This phenomenon maybe only occurred in the Alps where glacier areas are smaller, but not other regions which is not found at least in China Reference: \nLIU Shiyin, ZHANG Yong, ZHANG Yingsong, DING Yongjian. 2009. Estimation of glacier runoff and future trends in the Yangtze River source region, China. Journal of Glaciology, Vol. 55, No. 190, 353-362\nShiqiang Zhang, Xin Gao, Xiaowen Zhang and Stefan Hagemann. 2012. Projection of glacier runoff in Yarkant River basin and Beida River basin, Western China. HYDROLOGICAL PROCESSES, 26, 2773–2781. (Li, Xiucang, National Climate Center, China Meteorological Administration)
466	3	14	53	14	53	12% of 2008 extent by 2100: if possible, separate by areas. Some areas will lose much more than (100-12)% of ice by 2100 (Cassardo, Claudio, University of Torino)
467	3	14	53	14	53	For the mentioned 12%, is it possible to also specify the range of projected values? (Mach, Katharine, IPCC WGII TSU)
468	3	15	2	15	2	what means "stored glacier ice"? (Cassardo, Claudio, University of Torino)
469	3	15	2	15	5	This is very important information but the peak melt water and peak melt water dates from the glacier have been projected between 2010 and 2050 for different regions of China. It will be more appropriate to mention the basis for spread of 40 years (i.e. from 2010 - 2050) (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
470	3	15	3	0	3	As mentioned earlier “peak meltwater” term may not be interchangeable with “peak of glacier degraded runoff” (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
471	3	15	3	15	5	The value given by Radic and Hock relates to remote areas of large glaciers and is primarily important concerning sea level. The peak discharge for water supply in densely inhabited regions with smaller and steeper mountain glaciers is much earlier and has already been passed in many catchments with small glaciers. This difference should be made clear. (Haeberli, Wilfried, University of Zurich)
472	3	15	3	15	5	peak meltwater will occur in modeling single glacier and the peak depend mainly on warming rate. If glacier sizes in a glacierized basin are smaller (for instance <2sqkm), it is possible for occurrence of peak. However, if scales of glacier areas in a glacierized basin are quite different, peak will not occur in future decades which glacier runoff will increase sequentially. (Li, Xiucang, National Climate Center, China Meteorological Administration)
473	3	15	4	15	6	The timing of peak runoff in the Nordic Countries has been studied extensively within the energy sector. There is a large uncertainty associated with differences in climate projections as modelled by different GCMs and RCMs. Most GCMs and RCMs still have spatial resolutions that are far coarser than needed for realistic mass balance modelling, making it necessary to apply special downscaling techniques and bias corrections in the glaciological modelling. However, the results of this indicates that in peak runoff is likely to occur in Iceland and Norway in the latter part of the century. These results should be discussed along with those from China, the European Alps and the world. The relevant reference is Jóhannesson, T., G. Aðalgeirsdóttir, A. Ahlstrøm, L. M. Andreassen, S. Beldring, H. Björnsson, P. Crochet, B. Einarsson, H. Elvehøy, S. Guðmundsson, R. Hock, H. Machguth, K. Melvold, F. Pálsson, V. Radi?, O. Sigurðsson and Th. Thorsteinsson. 2012. Hydropower, snow and ice. In: Thorsteinsson, Th., and H. Björnsson, eds. Climate Change and Energy Systems. Impacts, Risks and Adaptation in the Nordic and Baltic Countries. Nordic Council of Ministers, TemaNord 2011:502, 91–111 (available online from norden.org) ; see especially example figure 5.7 p. 104 and figure 5.9 p. 107. See also discussion on reference on ch. 3 p.51 line 37 (ICELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
474	3	15	5	15	8	It could be helpful to specify if this outcome is expected across scenarios. (Mach, Katharine, IPCC WGII TSU)
475	3	15	12	0	13	This may be the most appropriate statement regarding the role of glaciers to the downstream flow and contradictory to the statement of IPCC 2007 as stated in general comment and reflected in Thayyen and Gergan(2010). (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
476	3	15	13	0	23	These statements give rise to the impression that the major flow regimes of the Himalayan Rivers from its origin to the confluence are affected by the glacier contribution. In fact the role of glaciers in regulating the stream flow variations limit at 20-40% glacierisation, in varying glacio- hydrological regimes. Hence it is important to point out that the direct effect of glacier shrinkage is limited to the headwater region alone (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
477	3	15	18	0	0	Box 3-1. Given the relevance of this box to both chapters 3 and 24, the chapter team could consider making it a cross-chapter box. In such a case, the box would have greater visibility within the report and the authors who have developed it would be directly recognized within the box. (Mach, Katharine, IPCC WGII TSU)
478	3	15	18	16	12	Box 3.1: Please ensure there are no inconsistencies with the available information from Chapter 4 of WGI AR5. Careful additional checks needed, i.e., statement "It is virtually certain that these projections are more reliable than an earlier suggestion of complete disappearance by 2035" has to go. This phrase is misleading and wrong as it currently reads like the factual WGII AR4 error was a "not-so-reliable suggestion". (Plattner, Gian-Kasper, IPCC WGI TSU)
479	3	15	18	16	14	This box could also usefully reference the systematic review by Miller et al referred to above that shows when assessments only include studies that use robust methods for estimating glacier loss, the evidence is a consistent reduction in glacier mass and volume in the Hindu Kush-Karakoram-Himalayan chain. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
480	3	15	25	0	26	These are unsubstantiated observations. There is no peer reviewed study suggested about a possible higher melt rate after 1995. Or please give references. More over it is hard to understand the purpose of this sentence. (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
481	3	15	25	15	26	Is it possible to use calibrated uncertainty language to characterize the author team's degree of certainty regarding this potential increase? (Mach, Katharine, IPCC WGII TSU)
482	3	15	26	0	0	I would add here that there are very few field measurements of glacier mass balance in Himalaya and that the compilation is based on an evolving sample of mostly small accessible glaciers, not necessarily representative of the region where there are located (Berthier, Etienne, LEGOS)
483	3	15	41	15	42	Question if the statement 'It is virtually certain that these projections are more reliable than an earlier suggestion of complete disappearance by 2035 (Cruz et al 2007)' is needed. The IPCC has acknowledged that the 2007 WGII statement was 'poorly substantiated' and issued an errata. If this statement is kept, it should be re-written to make clear that the Cruz reference is the 'earlier suggestion' rather than the reference for the new projections being more reliable. eg 'It is virtually certain that these projections are more reliable than an earlier suggestion by Cruz et al 2007 of complete disappearance by 2035.' (AUSTRALIA)
484	3	15	41	15	42	It might be clearest to acknowledge that this was an "erroneous suggestion." (Mach, Katharine, IPCC WGII TSU)
485	3	15	42	0	0	Cogley et al. 2010 could also be cited here to explain the origin of the 2035 date in the 2007 WGII report (Cogley, J. G., et al. (2010), Tracking the Source of Glacier Misinformation, Science, 326, 924-925.) (Berthier, Etienne, LEGOS)
486	3	15	45	0	0	Bhutiyan, M. R., Kale, V.S., and Pawar, N. J.: Changing streamflow patterns in the rivers of northwestern Himalaya: implications of global warming in the 20th century, Curr. Sci., 95(5), 618-626, 2008.) (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)

#	Ch	From Page	From Line	To Page	To Line	Comment
487	3	15	45	0	0	Thayyen, R. J. and Gergan, J. T. (2010) Role of glaciers in watershed hydrology: a preliminary study of a "Himalayan catchment", The Cryosphere, 4, 115-128, doi:10.5194/tc-4-115-2010, 2010. (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
488	3	15	45	0	49	But the actual discharge shows declining trend (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
489	3	15	45	15	47	peak meltwater will occur in modeling single glacier and the peak depend mainly on warming rate. If glacier sizes in a glacerized basin are smaller (for instance <2sqkm),it is possible for occurrence of peak. However, if scales of glacier areas in a glacerized basin are quite different, peak will not occur in future decades which glacier runoff will increase sequentially. For the above reasons, occurrence of peak meltwater is impossible in 50 to 70 years at linear warming rate of 0.06K/a in Himalaya where glacier sizes are such wide from A few square kilometers to Dozens of square kilometers. (Li, Xiucang, National Climate Center, China Meteorological Adiministration)
490	3	15	51	15	52	70-200mm/year of additional meltwater, this result is unbelievable. \nThe result originates from Yasunari (2010) who cited Gao' result. Gao's result was estimated in a small glacier of central Tanggla Mountains, Glacier Dongkemadi using Fujita's method. It is only simple estimation. It is not able to extend to south side of Himalayas. Data of Black carbon and albedo was assumptive and estimation of ablation is obviously higher.\nReference:\nHongkai Gao, Xiaobo He,Baisheng Ye1 and Jianchen Pu. 2012. Modeling the runoff and glacier mass balance in a small watershed on the Central Tibetan Plateau, China, from 1955 to 2008. Hydrol. Process. 26, 1593–1603\nKoji Fujita, Takeshi Ohta and Yutaka Ageta. 2007. Characteristics and climatic sensitivities of runoff from a cold-type glacier on the Tibetan Plateau. Hydrol. Process. 21, 2882–2891. (Li, Xiucang, National Climate Center, China Meteorological Adiministration)
491	3	16	2	16	5	Dam safety is not the only criterion as the probability of catastrophic floods from impact waves triggered by large rock/ice avalanches into new lakes is systematically increasing with the increasing number of new lakes in proximity to large destabilizing icy rock walls (cf. Haeberli, W. (2013): Mountain permafrost — research frontiers and a special long-term challenge. Cold Regions Science and Technology. http://dx.doi.org/10.1016/j.coldregions.2013.02.004) (Haeberli, Wilfried, University of Zurich)
492	3	16	9	0	10	Contradictory to the statement in Page 15 Line21 (THAYYEN, RENOJ, NATIONAL INSTITUTE OF HYDROLOGY)
493	3	16	17	0	0	There are other references on flow projections, such as those of Ducharne et al (2007, 2009), on the Seine and the Somme in NW France. (Laignel, Benoit, University of Rouen)
494	3	16	17	16	17	Please elaborate the definitions of "runoff" and "streamflow". (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
495	3	16	17	16	17	Please elaborate the definitions of "runoff" and "streamflow". (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
496	3	16	17	17	12	Section 3.4.5 - There is no mentionof indirect effects of changes in precipitation and temperature through their effects on vegetation water use. In particular, the effects of changes in climate on the severity and frequency of events such as wildfire and pests and pathogens that can significantly change the water balance of vegetated areas. Changes in regimes of wildfire and in pests and diseases that result from changes in precipitation and temperature can potentially change evapotranspiration from vegetation canopies. (AUSTRALIA)
497	3	16	19	16	54	It gives an example of climate projection only from Had GCM. It should explain other GCMs data or models, from other institutions. (Kazama, So, Tohoku University)
498	3	16	26	16	26	Vis a vis the text "using the same seven climate model patterns", authors should specify which seven climate model patterns. This portion needs to be redraftedfor greater clarity. (UNITED STATES OF AMERICA)
499	3	16	28	16	28	The acronym PET is used for the first time without previous explanation of what it represents. (Portela, Maria Manuela, Instituto Superior Tecnico (IST))

#	Ch	From Page	From Line	To Page	To Line	Comment
500	3	16	31	16	31	shows (ITALY)
501	3	16	33	16	34	Correct the sentence "This uncertainty is several times that (20 to 40%) of observed between these methods over the baseline period (1961-1990)". (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
502	3	16	40	16	40	and also page 73: which line refers to 2°C and which one to 4°C? (Cassardo, Claudio, University of Torino)
503	3	16	44	16	45	Insert reference Falloon & Betts (2006) - this is already in the chapter reference list. (Falloon, Peter, Met Office Hadley Centre)
504	3	16	46	16	46	Insert reference Davie et al. (2013) which used CMIP5 models - this is already in the chapter reference list (Falloon, Peter, Met Office Hadley Centre)
505	3	16	47	16	48	Normalized spatial patterns of precipitation minus evaporation by global mean surface air temperatures between two RCPs may be relevant to this part. The results in the following article support this sentences. \nIshizaki, Y., T. Yokohata, S. Emori, H. Shiogama, K. Takahashi, T. Nozawa, T. Nakaegawa, N. Hanasaki, T. Ogura and M. Yoshimori 2013: Validation of a pattern scaling approach for determining the maximum available renewable freshwater resource. Journal of hydrometeorology. In second review. (Nakaegawa, Toshiyuki, Meteorological Research Institute)
506	3	16	47	16	54	as I have told previously, the analysis of regional trends could reveal more interesting and bigger patterns (Cassardo, Claudio, University of Torino)
507	3	16	49	16	54	add Three more references to highlight uncertainty projections for China, some changes for this part are as follows, "However, there are some regions.....change, specifically China (highlight), south Asia and....., with uncertainty in projected changes in precipitation (not rainfall) across some catchments in China, south Asia being particularly significant. Changes in average annual runoff are typically between 1 and 3 times as large as changes in average annual precipitation with higher responses occurring in arid regions and lower responses occurring in humid areas (Tang and Lettenmaier, 2012; Wang et al, 2012; Zhang et al, 2013; Wang et al, 2013) "\nReferences\n(1) Wang, G. Q. Zhang, J.Y. Jin, J.L. et al., 2012: Assessing water resources in China using PRECIS and VIC model, Journal of Hydrology and Earth System, 2012, 16: 231–240\n(2) Zhang, J.Y. Zhang. Wang, G.Q. Pagano, T. C. et al., 2013: Using hydrologic simulation to explore the impacts of climate change on runoff in the Huaihe River basin of China. Journal of Hydrologic Engineering, 2012, doi:10.1061/(ASCE)HE.1943-5584.0000581. (accepted, will be published in 2013)\n? Wang, G.Q. Zhang, J.Y. Xuan, Y.Q. et al., 2013: Simulating the impact of climate change on runoff in a typical river catchment of the Loess Plateau, China. Journal of Hydrometeorology, 2013. DOI: 10.1175 / JHM- D-12-081.1 (Accepted and will be published in 2013) (Wang, Guoqing, Nanjing Hydraulic Research Institute)
508	3	16	52	16	52	Please refer to AR5 WGI Ch12 (Plattner, Gian-Kasper, IPCC WGI TSU)
509	3	16	52	16	54	Could add a brief explanation of why runoff changes are much larger than precip changes (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
510	3	16	53	16	53	...between 1 and 3 times as large... A brief explanation seems in order here. (Fleming, Sean, Meteorological Service of Canada)
511	3	17	2	17	12	again, I think that it could be interesting also to show some figures related to seasons (Cassardo, Claudio, University of Torino)
512	3	17	3	17	3	It might be helpful to clarify if "annual discharge" is the same as runoff. (Mach, Katharine, IPCC WGII TSU)
513	3	17	9	17	10	As mentioned in the context of the executive summary, the ES says "very cold regions." Please clarify whether this is equivalent to the description here. (Mastrandrea, Michael, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
514	3	17	12	17	12	It could be mentioned here that projected fundamental changes in the hybrid flow regimes of the Pacific coast of Canada provide a particularly clear example of these effects. Some references include: (i) Whitfield PH and others (2002), Modelling streamflow in present and future climates: examples from the Georgia Basin, British Columbia. Canadian Water Resources Journal 27, 427–456; and (ii) Schnorbus MA and other (2011), Hydrologic Impacts of Climate Change in the Peace, Campbell and Columbia Watersheds, British Columbia, Canada. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 157 pp. (Fleming, Sean, Meteorological Service of Canada)
515	3	17	15	0	0	There are other works such as those of Ducharme et al (2009), on the groundwater in the Seine and the Somme basins in NW France. (Laignel, Benoit, University of Rouen)
516	3	17	19	17	23	Suggest a review be undertaken of the references to research conducted by Crosbie et al in 2010 and 2012. The 2010 paper examined groundwater systems nationally, the 2012 paper focussed on the Murray Darling Basin. (AUSTRALIA)
517	3	17	24	17	27	The range of projected (simulated) changes in groundwater recharge is largely due to "uncertainty in climate models" and due to natural variability of soils and vegetation. This has been shown for using a single GCM (CSIRO9) with a "double-CO2" scenario and a biophysically based model (Green, T.R., B.C. Bates, S.P. Charles and P.M. Fleming. 2007. Physically based simulation of potential effects of carbon dioxide altered climates on groundwater recharge, Vadose Zone J. 6:597-609). Different soil-vegetation combinations produced dramatically different changes in groundwater recharge, which also differed between to climate zones (spatially). Crosbie et al. (2012) subsequently simulated the spatial variability across Australia using the same approach, but with an ensemble of GCMs to estimate probabilities. Thus the statement on these lines is correct, but should not imply that uncertainty of GCM results is the only or main driver. Recharge is very sensitive to soils, vegetation and land management. (UNITED STATES OF AMERICA)
518	3	17	29	17	31	When considering a particular climate scenario, land areas where total runoff are projected to increase (or decrease) roughly coincide with the areas where groundwater recharge and thus renewable groundwater resources are projected to increase (or decrease) (Kundzewicz and Doll, 2009). Split into two sentences : "When considering a particular climate scenario, land areas where total runoff are projected to increase roughly coincide with the areas where groundwater recharge and thus renewable groundwater resources are projected to increase (Kundzewicz and Doll, 2009). Likewise, for land areas where total runoff are projected to decrease, renewable groundwater resources are projected to decrease." (UNITED STATES OF AMERICA)
519	3	17	32	17	33	The statement, "Increased precipitation intensity, for example, may decrease groundwater recharge due to an exceedance of infiltration capacity (typically in humid areas)...", is a speculative theoretical argument. There are very few observations not only of sub-daily precipitation intensities but also soil infiltration capacities. Evidence from tropical soils in humid areas of Uganda shows, in contrast, that groundwater recharge results preferentially from heavy (>10mm/day) rainfalls (Owor et al. 2009. Environ. Res. Lett. Vol. 4, 035009). The role of macropores in enabling rain-fed recharge to largely bypass the soil matrix in both humid and semi-arid environments (as subsequently indicated on lines 33 and 34) has not been sufficiently considered (Beven and Germann, 2013. Water Resour. Res. DOI: 10.1002/wrcr.20156), particularly by the modelling community. (Taylor, Richard, UC London)
520	3	17	37	17	38	In addition to noting that the "vegetation adapts", a more explicit statement is needed regarding the importance of existing vegetation responses to atmospheric CO2 in terms of carbon assimilation rates and stomatal conductance, which increases water use efficiency and may increase biomass with increasing CO2. (UNITED STATES OF AMERICA)
521	3	17	43	17	43	Should this read 'reduced groundwater recharge' instead of 'increased groundwater abstractions'? (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
522	3	17	49	17	49	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
523	3	17	49	17	50	An additional reference (Loaiciga et al., 2011, Ground Water; 50(1),37) describes a analysis of potential impacts of sea level rise to groundwater in a California coastal urban aquifer. (UNITED STATES OF AMERICA)
524	3	17	50	17	54	The sentence started from "Assuming.....to (Webb and Howard, 2011) on line 54" is an important impact on fresh water resources, in particular due to sea level rise. Hence, required a little bit more explanation for the sake of clarity as it is a bit difficult to understand at a glance. (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
525	3	17	53	17	53	...saltwater intrusion is a very slow process that may take centuries... Strongly suggest refining the phrasing here. Saltwater intrusion can in fact happen very quickly under groundwater extraction (pumping), a common problem in coastal areas, and especially in island locations. (Fleming, Sean, Meteorological Service of Canada)
526	3	18	2	18	3	Regarding groundwater studies in atolls, suggest citing: White, I., Falkland, T., Metutera, T., Metai, E., Overmars, M., Perez, P., and Dray, A. (2007). "Climatic and Human Influences on Groundwater in Low Atolls." Vadose Zone J, 6(3), 581-590. (UNITED STATES OF AMERICA)
527	3	18	9	18	15	Taylor et al. (Nature Climate Change, 3(4): 322-329, 2013. DOI:10.1038/NCLIMATE1744) cited studies (Table 1) attributing a significant portion of historical sea level rise to groundwater abstraction. This could be included in this paragraph. (UNITED STATES OF AMERICA)
528	3	18	9	18	15	This paragraph could be split in two; one to address issues of groundwater-streamflow interactions, and the other to address the growing recognition of groundwater interactions with the climate. The former is a well-known process and could also be generalized to include impacts on surface water springs, which are also dependent on groundwater elevations and their intersection with the ground surface. The latter (as also summarized in Taylor et al. 2013) can be broadened to include soil moisture and irrigation topics (e.g., Lobell et al., 2008, J. Climate, 22, 2248) and the treatment of groundwater in land surface models. Indeed, it seems there is an increasing interest in using integrated hydrologic (and climate) models (e.g, Maxwell et al., 2007; Adv Wat. Resourc., 12, 2447;) to examine more carefully climate change issues in the "critical zone" between the Planetary Boundary Layer (PBL) and the water table. (UNITED STATES OF AMERICA)
529	3	18	15	18	15	7 m below ground: in this case, the ET is almost null and has no effects? Also in case of heavy rainfall? (Cassardo, Claudio, University of Torino)
530	3	18	18	0	0	There are other works such as those of Ducharne (2008) and Ducharne et al (2009) on the quality of waters of the Seine. (Laignel, Benoit, University of Rouen)
531	3	18	18	18	39	Section 3.4.7 - A number of potential effects of climate change on water quality are discussed. One omission is that of the effects of wildfire on water quality. Many cities around the world rely on good quality water from forested catchments that requires very little treatment. The increased risk of wildfire frequency and severity in these areas could have severe consequences on the quality of water derived from these catchments. Hugh G. Smith , Gary J. Sheridan, Patrick N.J. Lane , Petter Nyman, Shane Haydon 2011. Wildfire effects on water quality in forest catchments: A review with implications for water supply. Journal of Hydrology 396: 170-197 (AUSTRALIA)
532	3	18	18	18	39	Section co-minlges climate and water quality with projections of climate and water quality in a hard to follow mode. Most projections are useful in affirming that observed impacts will be likely to prevail in the future. The authors need to clarify if the observed impacts are 'climate impacts' or 'climate change impacts' (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
533	3	18	27	18	28	change "and this is available where the" with "and, where this is available, the" (Cassardo, Claudio, University of Torino)
534	3	18	42	18	42	This section could recognise the impact of changed fire regimes on soil erosion, sediment load and water quality. Chapter 25, page 24, lines 43-45 recognise this connection for Australia and provide references. (AUSTRALIA)
535	3	18	42	18	42	Do you have any information on the consequences of sedimentation on water storage capacity and risks to water supply? (Bunn, Stuart, Griffith University)
536	3	18	42	19	25	Section 3.4.8 - Soil Erosion and sediment loads are discussed as a function of changes in precipitation erosivity. Little mention is given the role of vegetation in erosion control, and therefore the risk of increased erosion after changes in vegetation structure. For example, high-magnitude erosion events after wildfire have been documented in south-eastern Australia. Petter Nyman, Gary J. Sheridan, Hugh G. Smith, Patrick N.J. Lane, 2011. Evidence of debris flow occurrence after wildfire in upland catchments of south-east Australia. Geomorphology 125: 383–401 (AUSTRALIA)
537	3	18	42	19	25	Section 3.4.8: Please add references to the corresponding and most up to date WGI assessment, e.g., p18144 regarding heavy rainfall events. (Plattner, Gian-Kasper, IPCC WGI TSU)
538	3	18	45	18	45	Authors should change "total rainfall contribution" to " total rainfall contribution in many regions." (UNITED STATES OF AMERICA)
539	3	18	45	18	47	As appropriate, it would be helpful to specify the relevant scenarios of climate change for this projection. (Mach, Katharine, IPCC WGII TSU)
540	3	18	49	18	49	Instead of "up to," the full range, including the lower bound, should be specified for this expected outcome. (Mach, Katharine, IPCC WGII TSU)
541	3	18	51	18	51	Instead of "up to," the full range, including the lower bound, should be specified for this expected outcome. (Mach, Katharine, IPCC WGII TSU)
542	3	18	54	18	54	Authors should replace 'giving rise to a decline' with 'and thus a decline.' (UNITED STATES OF AMERICA)
543	3	19	1	0	0	Chapter 3 on Freshwater has a structural problem. Chapt. 3.2 is about observed hydrological impacts of climate change and chapt. 3.4 on projected hydrological changes. In chapt. 3.4.9 (i.e. a sub-chapter dealing with projections) there are several statements dealing with the past. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
544	3	19	2	0	0	This sentence seems incorrect. GCMs do not "project" soil erosion. Suggest clarifying regarding scenarios used, etc. (CANADA)
545	3	19	3	19	3	5-195%: is this the right range? is it meaningful for the report? (ITALY)
546	3	19	6	19	6	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
547	3	19	7	19	8	For this projection, it could be helpful to specify the relevant baseline and scenarios of climate change. (Mach, Katharine, IPCC WGII TSU)
548	3	19	9	19	9	It is unclear if 'Projected rivers sediment flux' refers to Danish projected rivers in previous sentence or projected sediment flux in rivers more broadly. (AUSTRALIA)
549	3	19	10	19	14	It would be helpful to specify the relevant scenarios of climate change or temperature increase for these projections. (Mach, Katharine, IPCC WGII TSU)
550	3	19	17	19	17	Suggest adding another citation to Lu et al (2010) - Moore RD and others (2009), Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality, Hydrologic Processes 23: 42–61. (Fleming, Sean, Meteorological Service of Canada)

#	Ch	From Page	From Line	To Page	To Line	Comment
551	3	19	18	19	18	Going beyond the provided 26%, it would be preferable to specify the range for this projected outcome. (Mach, Katharine, IPCC WGII TSU)
552	3	19	18	19	19	For this statement, the relevant findings of working group 1 could be cross-referenced. (Mach, Katharine, IPCC WGII TSU)
553	3	19	21	19	21	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
554	3	19	23	0	0	Should it be "The or These" instead of "There" impacts of climate change.... In the sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
555	3	19	23	19	23	change "There" with "These" (Cassardo, Claudio, University of Torino)
556	3	19	24	19	24	change "is" with "are" and "one" with "ones" (Cassardo, Claudio, University of Torino)
557	3	19	28	0	0	Section 3.4.9. The chapter team should make sure that this section clearly and directly supports the corresponding key findings within the executive summary (for example, paragraph 2 within the executive summary?). (Mach, Katharine, IPCC WGII TSU)
558	3	19	28	20	26	Section 3.4.9: Please include references to the corresponding WGI assessment, WGI TSU FOD comment: "Extreme Hydrological Events (Floods, Drought) – includes an assessment of regional and global scale droughts and floods. Relevant WGI AR5 Chapters need to be referred to as the primary basis here. (Plattner, Gian-Kasper, IPCC WGI TSU)
559	3	19	30	19	31	The text states that leaf area is modelled to decrease in a warmer climate in Australia. This is inconsistent with the observed pattern of woody thickening throughout Australia and across semi-arid regions of the globe. See Macinnis-Ng, C., Zeppel, M., Williams, M., Eamus, D. (2011) Applying a SPA model to examine the impact of climate change on GPP of open woodlands and the potential for woody thickening. Ecohydrology, 4: 379-393 and references cited there-in. We postulate that extra soil moisture remaining in the soil due to water savings associated stomatal responses to rising CO2 stimulate additional plant growth, indicating the the role of climate change in driving woody thickening (increasing density of strubs and trees in the landscape). Whatever the cause of woody thickening, it causes an increase (not decrease) in leaf area across the landscape as grasslands are converted to woodlands. What type of model is predicting leaf area will decrease in a warmer climate? It is not consistent with analysis of areal photos and other approaches. For instance, see Fensham, RJ, Fairfax, RJ and Archer, R 2005, 'Rainfall, land use and woody vegetation cover in semi-arid Australian savannah', Journal of Ecology, vol. 95, pp 596-606. I argue that leaf area is not decreasing across the landscape and I therefore question whether groundwater recharge will increase (especially if rainfall is decreasing). See chapter 4 page 39 lines 5-13 (Macinnis-Ng, Cate, University of Auckland)

#	Ch	From Page	From Line	To Page	To Line	Comment
560	3	19	30	20	4	Here, Figure 3-8 by Dankers et al. (2013) is used to show future flood hazard changes, while both Dankers et al. (2013) and Hirabayashi et al. (2013) are cited in text. However, the figures provided in Hirabayashi et al. (2013) are more comprehensive and informative than that of Dankers et al. (2013) in terms of three aspects. Those three aspects are 1) inclusion of all multiple RCP scenarios rather than RCP8.5 only, 2) larger number of models (11 GCMs including all models from independent institutes providing runoff data, rather than 5 GCMs), 3) evaluation of uncertainty in change by counting model agreement in showing the same direction (increase or decrease of flood) of change, and a new bootstrap-based analysis, and 4) application of a recent state-of-the-art global river model with inundation scheme to estimate river discharge and inundation area, rather than using a relatively simple river routing model. An advantage of Dankers et al. (2013) is the use of runoff simulation of nine global hydrology and land surface models forced by climate projections by GCMs with bias correction. Even though, their calculated river flow is less biased than the calculation of Hirabayashi et al. (2013), who used runoff simulation by GCMs directly, future change of disastrous flood hazard having return period of 30-year or 100-year could be captured even in the runoff estimation in GCMs. The calculation using different global hydrology and land surface models can be a source of additional uncertainty, as shown by numerous model Intercomparison projects until now, while the estimation of Hirabayashi et al. (2013) is only influenced by model spread among GCMs. Dankers et al. (2013) showed changes in discharge having return period 30-year, while Hirabayashi et al. (2013) showed the result of flood corresponding to 100-year return period. As shown in Figure S8 of Hirabayashi et al. (2013), global distribution of future changes in 10-, 30- and 100-year flood are similar. Figures of future projection of 30-year flood with uncertainty range for 11 GCMs and 4 RCP scenarios are ready to be provided, if required. Hence, I suggest the authors to consider including figures and analysis by Hirabayashi et al. (2013) in Figure 3-8, not because I am an author of that paper, but figures by Hirabayashi et al. (2013), in general, are scientifically more comprehensive and relevant than the current one used in this paragraph. (Hirabayashi, Yukiko, The University of Tokyo)
561	3	19	31	19	31	Low confidence in projections of changes of fluvial floods. (Llasat, Maria-Carmen, University of Barcelona)
562	3	19	35	19	35	change "couple" with "coupled" (Cassardo, Claudio, University of Torino)
563	3	19	37	19	37	... with a great variability *even* at the scale... Better: but with great variability at the scale of individual river basins. At the global scale, the increase is more robust. (Dankers, Rutger, Met Office Hadley Centre)
564	3	19	39	19	39	East Africa, Central and Western Africa: why you do not say simply Africa? Also page 33 line 20 (Cassardo, Claudio, University of Torino)
565	3	19	43	19	44	Please clarify whether this statement is the basis for the agreement/evidence presented in the executive summary. (Mastrandrea, Michael, IPCC WGII TSU)
566	3	19	45	19	46	Not just among GCMs, but also among impact models (hydrological and land surface models). This means that impact models contribute to the uncertainty in the projections. A consequence of this is that studies relying on a single impact model may underestimate uncertainty, even if they are applied to single river basins. Reference: Dankers et al., 2013. (Dankers, Rutger, Met Office Hadley Centre)
567	3	20	6	20	7	Kay & Jones (2012) is not "catchment or river basin scale", but country scale. Similarly, Rojas et al. (2012) is at continental scale. (Dankers, Rutger, Met Office Hadley Centre)
568	3	20	6	20	9	Include a brief summary of the results from the catchment-scale studies. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
569	3	20	8	20	9	Several projections in developing countries were recently published, and these publications listed below should be cited here:\n* Mekong River in Vietnam: Kwak, Y., K. Takeuchi, K. Fukami, and J. Magome 2012: A new approach to flood risk assessment in Asia-Pacific region based on MRI-AGCM outputs. Hydrological Research Letters 6, 70-75.doi: 10.3178/HRL.6.70\n* Chao Phraya River in Thailand: Kure, S., and T. Tebakari 2012: Hydrological impact of regional climate change in the Chao Phraya River Basin, Thailand. Hydrological Research Letters 6, 53-58. DOI: 10.3178/HRL.6.53\n* Tana River in Kenya: T. Nakaegawa, C. Wachana, and KAKUSHIN Team-3 Modeling Group. First impact assessment of hydrological cycle in the Tana River basin, Kenya, under a changing climate in the late 21st Century. Hydrological Research Letters., Vol. 6, pp.29-34, (2012) .\n* Chao Phraya River in Thailand. Champathong, A. D. Komori, M. Kiguchi, T. Sukkhapunnapan, T. Nakaegawa, and T. Oki. 2013: Future projection of mean river discharge climatology for the Chao Phraya River basin. Hydrological Research Letters. Vol.7, in press.\n* Panama: J. Fabrega, T. Nakaegawa, R. Pinzon, K. Nakayama, O. Arakawa, SOUSEI Theme-C modeling group. 2013: Hydroclimate projections for Panama in the late 21st Century. Hydrological Research Letters. Vol.7., in press.\n* Tigris River: Akio Kitoh, Akiyo Yatagai and Pinhas Alpert: "First super-high-resolution model projection that the ancient "Fertile Crescent" will disappear in this century", Hydrological Research Letters, Vol. 2, pp.1-4, (2008) . (JAPAN)
570	3	20	9	0	0	Several projections in developing countries are recently published and may be cited here:\n* Mekong River in Vietnam: Kwak, Y., K. Takeuchi, K. Fukami, and J. Magome 2012: A new approach to flood risk assessment in Asia-Pacific region based on MRI-AGCM outputs. Hydrological Research Letters 6, 70–75.doi: 10.3178/HRL.6.70\n* Chao Phraya River in Thailand: Kure, S., and T. Tebakari 2012: Hydrological impact of regional climate change in the Chao Phraya RiverBasin, Thailand. Hydrological Research Letters 6, 53–58. DOI: 10.3178/HRL.6.53\n* Tana River in Kenya: T. Nakaegawa, C. Wachana, and KAKUSHIN Team-3 Modeling Group. First impact assessment of hydrological cycle in the Tana River basin, Kenya, under a changing climate in the late 21st Century. Hydrological Research Letters., Vol. 6, pp.29-34, (2012) .\n* Chao Phraya River in Thailand. Champathong, A. D. Komori, M. Kiguchi, T. Sukkhapunnapan, T. Nakaegawa, and T. Oki. 2013: Future projection of mean river discharge climatology forthe Chao Phraya River basin. Hydrological Research Letters. Vol.7, in press.\n* Panama: J. Fábrega, T. Nakaegawa, R. Pinzón, K. Nakayama, O. Arakawa, SOUSEI Theme-C modeling group. 2013: Hydroclimate projections for Panama in the late 21st Century. Hydrological Research Letters. Vo.7., in press.\n* Tigris River: Akio Kitoh, Akiyo Yatagai and Pinhas Alpert: “First super-high-resolution model projection that the ancient “Fertile Crescent” will disappear in this century”, Hydrological Research Letters, Vol. 2, pp.1-4, (2008) . (Nakaegawa, Toshiyuki, Meteorological Research Institute)
571	3	20	9	20	9	Include Fábrega et al., 2013 as a cite after Khazaei et al., 2012. The corresponding reference is: J. Fábrega, T. Nakaegawa, R. Pinzón, K. Nakayama, O. Arakawa, SOUSEI Theme-C modeling group. 2013: Hydroclimate projections for Panama in the late 21st Century. Hydrological Research Letters Vol. 7, in press. (Fábrega, José, Universidad Tecnológica de Panamá)
572	3	20	11	20	13	Southern and central Europe may experience longer and more frequent droughts. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
573	3	20	11	20	19	For these statements, the chapter team should consider cross-referencing relevant findings in the working group 1 contribution to the 5th assessment report as well. (Mach, Katharine, IPCC WGII TSU)
574	3	20	11	20	26	Taylor et al. 2012 provides a new reference on global drought assessment using different metrics, and a large ensemble, and also looks at the impact of mitigation. The paper is now accepted in HESS and the latest version includes a runoff based index. I. H. Taylor, E. Burke, L. McColl, P. Falloon, G. R. Harris, and D. McNeall, 2012.Contributions to uncertainty in projections of future drought under climate change scenarios. Hydrology and Earth System Sciences Discussions, 9, 12613?12653, doi:10.5194/hessd-9-12613-2012. (Falloon, Peter, Met Office Hadley Centre)

#	Ch	From Page	From Line	To Page	To Line	Comment
575	3	20	11	20	26	The paragraphs on drought are very poorly populated with references. There should be some more detailed information on the definitional issues (se e.g., Vidal et al., 2010), but also much more informed regional projection results (see, e.g., Vidal and Wade., 2009, Vidal et al., 2012).\n- Vidal, J.-P.and Wade, S. D. (2009) A multimodel assessment of future climatological droughts in the United Kingdom. International Journal of Climatology, 29(14), 2056-2071. doi: 10.1002/joc.1843\n- Vidal, J.-P., Martin, E., Franchistéguy, L., Habets, F., Soubeyroux, J.-M., Blanchard, M., and Baillon, M. (2010) Multilevel and multiscale drought reanalysis over France with the Safran-Isba-Modcou hydrometeorological suite. Hydrology and Earth System Sciences, 14(3), 459-478. doi: 10.5194/hess-14-459-2010\n- Vidal, J.-P., Martin, E., Kitova, N., Najac, J., and Soubeyroux, J.-M. (2012) Evolution of spatio-temporal drought characteristics: validation, projections and effect of adaptation scenarios. Hydrology and Earth System Sciences, 16(8), 2935-2955. doi: 10.5194/hess-16-2935-2012 (Vidal, Jean-Philippe, Irstea)
576	3	20	11	20	26	A key reference on droughts based on the ISI-MIP project (hence using the CMIP5 simulations) is Prudhomme et al. (submitted to PNAS); you may wish to contact the lead author Christel Prudhomme (chpr@ceh.ac.uk).\nOne of their findings is that impact model formulation is a key uncertainty in drought projections. Models that do not include the effect of changes in vegetation under higher CO2 concentrations (like most hydrological models) give different results compared to those models that do (mostly land surface and ecosystem models). See also Davie et al. 2013 (already referenced). (Dankers, Rutger, Met Office Hadley Centre)
577	3	20	29	0	0	This part is particularly clear, interesting and relatively complete. (Laignel, Benoit, University of Rouen)
578	3	20	31	21	32	Section 3.5.1 - No mention is made of water resources derived from forested areas, and the potential of indirect effects of climate change on vegetation and how the quantity and quality of water resources can be compromised. (AUSTRALIA)
579	3	20	31	21	32	According to the diagnosis made by the World Bank about water resources management in Chile, the availability of water in the country is much higher than the world average value and the threshold considered for sustainable development, but this availability is distributed in a very uneven way throughout the country. Considering this reality and adding the projections of climate change impacts on water resources, the proposed solutions and adaptation measures should consider aspects of <u>distribution and sustainable resource use</u> . (CHILE)
580	3	20	33	20	37	This does not include the middle east, which is very odd given it is a region under major threat of water insecurity (see HDR 2006) (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
581	3	20	35	20	35	eastern and northeastern China, "northeastern" is advised to be removed (xia, chaozong, academy of forest inventory and planning)
582	3	20	44	20	44	The resent studies for the water-stress based on water withdrawal-to-availability ratio should be added. For example, Hanasaki et al. (2012) and Hayashi et al. (2013).\nN. Hanasaki, S. Fujimori, T. Yamamoto, S. Yoshikawa, Y. Masaki, Y. Hijioka, M. Kainuma, Y. Kanamori, T. Masui, K. Takahashi, and S. Kanae (2012) A global water scarcity assessment under shared socio-economic pathways – Part2: Water availability and scarcity, Hydrol. Earth Syst. Sci. Discuss., 9, 13933–13994.\nA. Hayashi, K. Akimoto, T. Tomoda, M. Kii (2013) Global evaluation of the effects of agriculture and water management adaptations on the water-stressed population, Mitig Adapt Strateg Glob Change, 18:591–618, DOI 10.1007/s11027-012-9377-3. (HAYASHI, Ayami, Research Institute of Innovative Technology for the Earth (RITE))
583	3	20	49	20	49	Unclear if the additional 7% per 1 degree applies below 2.7 degrees of warming or above 2.7. Consider replacing 'Up to this temperature rise' with 'After this temperature rise' to make clear. (AUSTRALIA)
584	3	20	54	21	9	There is a strong degree of consistency in projections... and the specific measure of stress or scarcity used. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
585	3	20	54	21	21	Normalized spatial patterns of precipitation minus evaporation by global mean surface air temperatures between two RCPs may be relevant to this part. The results in the following article support this sentences. \nIshizaki, Y., T. Yokohata, S. Emori, H. Shiogama, K. Takahashi, T. Nozawa, T. Nakaegawa, N. Hanasaki, T. Ogura and M. Yoshimori 2013: Validation of a pattern scaling approach for determining the maximum available renewable freshwater resource. Journal of hydrometeorology. In second review. (Nakaegawa, Toshiyuki, Meteorological Research Institute)
586	3	21	0	0	0	Figure 3.9. I am not sure this warrants inclusion - it is one study and does not necessarily reflect the consensus on the impacts of CC on groundwater and hence impacts on human populations. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
587	3	21	0	22	0	General comment - Section 3.5.2.1:\nThis section has focused on irrigation only. A discussion on water use on livestock (including feed and indirectly feed transportation costs) seems necessary. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
588	3	21	1	0	2	Are there results available for North and South America that could be included in this paragraph? (CANADA)
589	3	21	1	21	2	Add three more reference to highlight great variation in projected availability as follows, “.....but much greater variation in projected availability in South and East Asia, in particularly China (Zhang et al., 2013; Wang et al., 2012; Wang et al, 2013). Second,.....”. \nReferences\n(1) Wang, G. Q. Zhang, J.Y. Jin, J.L. et al., 2012: Assessing water resources in China using PRECIS and VIC model, Journal of Hydrology and Earth System, 2012, 16: 231–240\n(2) Zhang, J.Y. Zhang. Wang, G.Q. Pagano, T. C. et al., 2013: Using hydrologic simulation to explore the impacts of climate change on runoff in the Huaihe River basin of China. Journal of Hydrologic Engineering, 2012, doi:10.1061/(ASCE)HE.1943-5584.0000581. (accepted, will be published in 2013)\n?3?Wang, G.Q. Zhang, J.Y. Xuan, Y.Q. et al., 2013: Simulating the impact of climate change on runoff in a typical river catchment of the Loess Plateau, China. Journal of Hydrometeorology, 2013. DOI: 10.1175 / JHM- D-12-081.1 (Accepted and will be published in 2013) (Wang, Guoqing, Nanjing Hydraulic Research Institute)
590	3	21	1	22	0	This section has focused on irrigation only. A discussion on water use on livestock (including feed and indirectly feed transportation costs) seems necessary. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
591	3	21	3	21	7	I don't think the sentence of “climate change would, however, regionally exacerbate or offset population pressures” has a close and logical nexus with the main contents in the literature cited (Fung et al., 2011?, the meaning is not expressed clearly. Therefore, I suggest delete “Third, over the next few decades and for increases in global mean temperature of less than around 2? above pre-industrial, changes in population will generally have a greater effect on changes in resources availability, relative to the present day, than climate change (Fung et al., 2011). Climate change would, however, regionally exacerbate or offset population pressures”? Otherwise, it is necessary to revise this point so as to have a much clear expression. (wang, chunfeng, State Forestry Administration, China)
592	3	21	5	21	6	Passage is mis-phrased, as changes in population are not separate from climate change - in fact, population growth is a key driver of climate change. This is explicitly recognized in the SRES scenarios, for instance. For some additional relevant thoughts on the subject, consult Murtaugh PA, Schlax MG. (2009), Reproduction and the carbon legacies of individuals, Global Environmental Change. 19:14-20. (Fleming, Sean, Meteorological Service of Canada)
593	3	21	6	21	7	The statement needs a confidence qualifier and further explanation (for which regions and when). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
594	3	21	9	21	9	A key aspect of uncertainty here is the impact of elevated CO2 on transpiration and hence runoff - comment should be made on this here, with a link to box CC-VW (Falloon, Peter, Met Office Hadley Centre)

#	Ch	From Page	From Line	To Page	To Line	Comment
595	3	21	11	21	17	Exposure and vulnerability are now considered separately in the context of AR5 (see AR5 WGII Glossary). As characterized in Chapter 19 and the draft SPM and TS, both interact with physical changes to determine risks. The results presented in Figure 3-9 combine elements of exposure and vulnerability as defined in the AR5 WGII Glossary, and more nearly are an indication of future risks under different scenarios. Please consider the terminology here and its consistency with the glossary. (Mastrandrea, Michael, IPCC WGII TSU)
596	3	21	12	21	16	Especially mountainous areas with small catchment and with dry season make more severe water resources rising water conflicts. (Ekkawatpanita et al., Assessment of water conflict in Mae Chaem River Basin, Northern Thailand, Water International, Vol.34, No.2, pp. 242-263, 2009). (Kazama, So. Tohoku University)
597	3	21	19	21	19	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
598	3	21	19	21	25	Under climate change, reliable surface water supply is... and thus renewable groundwater resources (Kundzewicz and Doll, 2009). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
599	3	21	19	21	32	The concept and application of "conjunctive use," managing groundwater and surface water supplies together, is increasingly used to add reliability to water supply systems (in California, see, for example, "Groundwater and Surface Water in Southern California: A Guide to Conjunctive Use", published by Association of Groundwater Agencies, 2000, www.agwa.gov, or Pulido-Velazquez et al., 2004, Water Resource. Res., 40(3), DOI: 10.1029/2003WR002626; Hanson et al., 2012, Water Resource. Res., W00L08, doi:10.1029/2011WR010774). Although often developed to augment existing supplies, reduce uncertainty in imported supplies, or bank water in aquifers for droughts, their utility may be equally, if not more relevant for climate change adaptation purposes. The Orange County Water district, for example, has developed and maintained a significant groundwater recharge effort (http://www.ocwd.com/ProgramsProjects/GroundwaterRecharge.aspx) which is augmented by additional recycled water from an advanced waste water treatment plant (http://gwrsystem.com/about-gwrs.html). (UNITED STATES OF AMERICA)
600	3	21	22	21	23	The statement 'However, this option is only sustainable where groundwater withdrawals remain well below groundwater recharge' is not justified. Why only if withdrawal remains below recharge and not simply just below? What is the authors definition of 'well below'? This needs to be provided. On what timescales do the believe this balance should happen over ? This needs to be defined. My view is that given greater fluctuations in surface water flow, there may be a case to be made that groundwater withdrawals that exceed recharge on annual basis or even multi-year basis may be justified provided over longer time periods (e.g. decadal) withdrawals do not exceed recharge. This statement needs either to be deleted, nuanced and if kept much better evidenced as currently it is not helpful nor accurate. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
601	3	21	22	21	23	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. Also, please note that the relevant likelihood term may be "unlikely," as "not likely" is not a designated likelihood term. (Mach, Katharine, IPCC WGII TSU)
602	3	21	26	21	26	Please spell out the acronym GWR (AUSTRALIA)
603	3	21	26	21	26	GWR = ground water resources...? I don't see this acronym explicitly defined. Further, I suggest avoiding three-letter acronyms whenever possible. (Fleming, Sean, Meteorological Service of Canada)
604	3	21	31	0	0	Terms "cprojected" and "1% to s a" need to be revised in the sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
605	3	21	31	21	31	Words missing at the end of line 31. Possibly should read 'is projected to suffer a'. (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
606	3	21	32	21	32	Suggest adding something to the effect of, "Further, many aquifers worldwide contain so-called fossil water, and virtually any extraction is in excess of recharge rates, constituting groundwater mining; the Ogallala Aquifer of the midwestern US is a well-known example." (Fleming, Sean, Meteorological Service of Canada)
607	3	21	35	21	54	According to the diagnosis on the management of water resources in Chile, made by the World Bank, irrigated agriculture represents a 73% of water use in the country, so it is vital that adaptive processes aimed at a more efficient use, which can be promoted through bonus systems to technification irrigation systems. The modernization can pass from an efficiency rate of 30% (gravity irrigated) at rates close to 90% (drip irrigation). In Chile, Law No. 18,450 for the Promotion of Private Investment in Irrigation, promotes the construction of irrigation projects in order to increase the irrigated area and encourage more efficient use of water resource (CHILE)
608	3	21	35	22	30	An agricultural systems model, including CO2 effects on crops, simulated decreased wheat grain yield with increased transpiration under projected climate change, and adaptation in planting dates did not mitigate yield declines (Ko, J., L.R. Ahuja, S.A. Anapalli, T.R. Green, L. Ma, D.C. Nielsen and C.L. Walthall. Climate change impacts on dryland cropping systems in the Central Great Plains, USA. Climatic Change. 111(2):445-472. 2012). This study may be worth citing as an example for non-irrigated agriculture. (UNITED STATES OF AMERICA)
609	3	21	37	21	47	Irrigation water requirement is decreasing by the 2080s? What is the reason for this and what is the probability for this estimation? This is in contrast to the expected increase in Southern Europe, China, USA and Russia. Should it be an "increase" instead of decrease? (GERMANY)
610	3	21	37	22	30	The agriculture section (3.5.2.1) is notably weak. Some statements are made twice, while other seemingly contradictory statements on CO2 fertilization vs. water limitation are presented back-to-back with inadequate explanation. The content appears to be acceptable, if properly explained, but the section needs a careful rewrite to ensure that it is clear to the reader. (UNITED STATES OF AMERICA)
611	3	21	39	21	47	This paragraph needs rephrasing. Lines 39-40 state that irrigation demand is likely to rise with higher temperatures, but lines 43-44 say it could decrease or remain the same. Then, lines 46-47 say irrigation demand could rise. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
612	3	21	41	21	41	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
613	3	21	42	21	42	why "a" global vegetation and hydrology? Do you mean that 19 climate models were used to drive a single model for vegetation and hydrology? (Cassardo, Claudio, University of Torino)
614	3	21	42	21	45	Where authors say "would decrease by" ... Did they mean to say "increase"? The thoughts that precede and follow this statement suggest irrigation requirement increases, so this statement suggesting a decrease is confusing. (UNITED STATES OF AMERICA)
615	3	21	42	21	45	As appropriate, the relevant scenarios of climate change for these projections could be specified. (Mach, Katharine, IPCC WGII TSU)
616	3	21	44	21	44	Please explain why irrigation water requirements would decrease. The decrease is confusing in the context of this paragraph which refers to increasing irrigation water demands. (AUSTRALIA)
617	3	21	49	21	49	Irrigating crops can influence regional... key elements for food security in the future. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
618	3	21	49	21	49	over 40% => "about 40%": In FAO fact book, 80% rainfed area produce more than 60% of food (REPUBLIC OF KOREA)
619	3	21	49	21	49	change "considerable" in "considerably" (Cassardo, Claudio, University of Torino)

#	Ch	From Page	From Line	To Page	To Line	Comment
620	3	21	49	21	50	Consider rephrasing and better linked to subsequent section. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
621	3	21	52	22	2	this sentence refers to past, present or future? You says "alters", "can be" (so, now) and then "warmed" (in the past)... please check! (Cassardo, Claudio, University of Torino)
622	3	21	52	22	9	Cooling and warming effects of irrigation seem to be very significant (Canada is warmed by about 1 °). This should be explained in more detail and reflected as a world wide feasible adaption strategy. (GERMANY)
623	3	21	53	22	4	The paragraph is a bit ambiguous, in particular, when it is mentioned that increase in cloud cover have cooling effect in southern US, China and in parts of Asia whereas, 1 Degree C warming is reported in Canada. It needs proper citation and brief explanation for such a contrasting effects in different regions. (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
624	3	21	54	21	54	The phrase 'climate change will deteriorate soil erosion' is unclear. Perhaps 'climate change will exacerbate soil erosion' is a better way of saying it. (Macinnis-Ng, Cate, University of Auckland)
625	3	22	0	0	0	Please insert comments: "In mosoon area for paddy rice cultivation, irrigation water requirement would be possibly decreased due to rainfall increasing and crop growing period shortening [ref: Yoo, S. H., J.-Y. Choi, S.-H. Lee, Y.-G. Oh, D. k. Yun, 2013, Climage change impacts on water storage requirements of an agricultural reservoir considering changes in land use and rice growing season in Korea, Agricultural Water Management, Vol. 117, 43-54 (REPUBLIC OF KOREA)
626	3	22	0	0	0	One of the fundamental assumptions in this chapter is apparently that climate change impacts freshwater resources primarily through shifts in variability. Nowhere is there is a kind of clear, consistent vision about transformation seen in other chapters. Shifts in variability are critically important, and long term shifts in a wide variety of mean climate states are extremely important, especially since water infrastructure (a) lasts over climate relevant timescales, and (b) embodies critical assumptions about future eco-hydrological conditions. Resilience in the context of water can refer to either returning to a "norm" condition following an extreme event or to enduring transformation. These concepts are discussed in Le Quesne et al. 2010, Flowing Forward, World Bank (see figure 2.1). A more recent version of the same figure is in 2013 OECD document ENV/EPOC/WPBWE(2013)2/REV1. (Matthews, John, Conservation Internatonal)
627	3	22	0	0	0	This largely only discusses the benign connections between mitigation and adaptation. There are a number of areas where these connections are competitive. For instance, many "clean energy" approaches may ultimately limit the options available for climate adptation. Hydropower - especially storage - is an obvious connection. But Infrastructure connected to high-value biofuels such as sugarcane and corn-based ethanal reflect extractive non-renewable consumption of water resources. Moreover, groundwater pumping itself may be a major consumer of energy, as in much of Indian agriculture. The Indian blackouts of 2012 in some way are a nexus of low hydro generation with elevated power consumption by farmers for irrigation. (Matthews, John, Conservation Internatonal)
628	3	22	1	0	0	Most of Canada's land area does not have irrigation. Is this statement about warming in Canada specifically referring to the Canadian Prairies? Suggest reviewing and revising. (CANADA)
629	3	22	1	22	1	It warmed in what part of "Canada", the world's second largest nation by area, with irrigated agriculture occuring only in certain regions? The prairie provinces, perhaps? I rather doubt that irrigation affected the climate of the northern tundra or Canadian shield or Pacific Coast, for example. Please be specific - this passage, as written, seems of little use to readers and might be a little misleading. (Fleming, Sean, Meteorological Service of Canada)
630	3	22	2	0	4	This sentence is confusing. Suggest reviewing. (CANADA)
631	3	22	3	22	3	Incomplete sentence, words missing following 'weaker summer'. (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
632	3	22	3	22	3	End of sentence missing "... weaker summer ..." what? Monsoon? (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
633	3	22	3	22	3	Suggest authors replace 'weaker summer' with 'weaker summer monsoon in response to cooler temperatures.' (UNITED STATES OF AMERICA)
634	3	22	6	22	9	As indicated in this paragraph, irrigation is considered an adaptation strategy, but we think that is necessary to focus on the mechanized irrigation systems because efficiency rates are very different between one system to another (30% in tilled irrigation systems to rates close to 90% in drip irrigation systems). (CHILE)
635	3	22	6	22	22	This section is rather poor and appears to be written in isolation from the previous text. For instance, there is discussion of expanding irrigation in Africa, but no cross-reference to the previous section on groundwater that made some very bold statements on the limitations of groundwater use. This is particularly problematic given that in most countries expansion of irrigation is likely to involve groundwater development, but this may be constrained given changes in recharge. The authors should look at the recent Macdonald et al (Environmental Research Letters 2012) for discussion on this. Expansion of irrigation is likely to be more limited in Asia given current levels of development, although again there is some indication from work by the World Bank in India that in fact the scope for managed aquifer recharge in the middle Gangetic plain could support expansion of groundwater based irrigation. In my view this section needs re-writing. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
636	3	22	6	22	30	This point "Irrigation as adaptation strategy" is small developed and little demonstrated. (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
637	3	22	7	0	8	It is not clear how fertilizer and pesticide use and irrigation can be used to change social, economic and climatic conditions. Suggest clarifying. This paragraph could also include some text regarding potential cautions associated with using irrigation as an adaptation option (e.g., over-use/reliance). (CANADA)
638	3	22	7	22	8	This is a broad sweeping statement with little evidence to support assertions (e.g. that farmers could change climatic, political or economic conditions through their use of fertilizers, pesticides and irrigation water). (AUSTRALIA)
639	3	22	7	22	22	This section seems a bit disconnected. Where is irrigation water coming from? Surface flows and groundwater sources both entail major tradeoffs between needs, one in real-time and one over time. Irrigation by itself is not a simple solution, and this is a complicated, emotional topic. Irrigation too - especially in semi-arid regions - can ultimately destroy crop yields as well by poisoning soils. (Matthews, John, Conservation International)
640	3	22	11	14	14	What is the climate cooling effect of 4 % irrigation in Sub-Saharan Africa? How much irrigation would be needed to stabilize regional climate conditions? Is this an option for mitigation and adaptation equally? (GERMANY)
641	3	22	13	22	13	Replace "and" with word "an" (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
642	3	22	16	22	17	The statement, "A study quantifying global changes in irrigation requirement on areas presently equipped for irrigation of major crop types has been realized indicating results from 19 GCMs for the year 2080.", requires a reference! (Taylor, Richard, UC London)
643	3	22	16	22	18	Again, where authors say "would decrease by" ... did they mean to say "increase"? The thoughts that precede and follow this statement suggest irrigation requirement increases, so this statement suggesting a decrease is confusing. (UNITED STATES OF AMERICA)
644	3	22	16	22	19	Please specify source and consider rephrase. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
645	3	22	16	22	19	Include reference for study referred to in text. (AUSTRALIA)
646	3	22	17	22	18	Sentence needs to be re-phrased such as "It found a decrease in global irrigation by about 17% in the ensemble median." (Ambulkar, Archis, Brinjac Engineering Inc.)

#	Ch	From Page	From Line	To Page	To Line	Comment
647	3	22	18	22	19	Sentence needs grammatical correction - present sentence "projected with (high likelihood) for..." (Ambulkar, Archis, Brinjac Engineering Inc.)
648	3	22	21	22	22	Did authors mean "Instance" instead of "Insance". Also, the sentence needs to be modified such as - "Shifts in sowing dates constitute an adaptation option, for instance, maize production in Switzerland..." (Ambulkar, Archis, Brinjac Engineering Inc.)
649	3	22	24	22	24	Suggest 'Complementary' should be 'Complementarity'? (AUSTRALIA)
650	3	22	24	22	30	A comparison of optimal input levels of nitrogen... higher with more marked climatic conditions (Finger et al, 2011). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
651	3	22	25	22	30	This result is from a single study for one region of Switzerland and the results may not be applicable to other areas. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
652	3	22	26	22	29	It is stated that "In rainfed production systems, reduced summer rainfalls lead to a reduction of the optimal production intensity for current and future scenarios. On the contrary, an increased application of nitrogen (i.e. a more intensive production) is an optimal response to climate change if irrigation is available". The reference provided only refers to maize production in Switzerland and the findings are definitely not transferable to other production systems, especially tropical and subtropical systems. Further, the application of nitrogen fertilisers can have an adverse mitigation outcomes. Increasing the use of nitrogen rich fertilisers to boost production as a means to compensate for reduced rainfall is likely to be a maladaptive approach. The risk is excess nitrogen will enter freshwater ecosystems through runoff. Excessive nitrogen in freshwater ecosystems can result in eutrophication and stimulate excessive weed growth. There is a significant amount of scientific literature on the impacts of excessive nitrogen on freshwater ecosystems. An example is: Tian, H, C. Lu, J Melillo, W Ren, Y Huang, X. Xu, M Liu, C Zhang, G Chen, S Pan, J Liu and J Reilly, 2012, Food benefit and climate warming potential of nitrogen fertilizer uses in China, Environmental Research Letters, 7, 044020, https://dash.archive.mblwhoilib.org/bitstream/handle/1912/5757/1748-9326_7_4_044020.pdf?sequence=1 . Other references can be supplied if requested. (AUSTRALIA)
653	3	22	27	22	28	The idea proposed here - increasing nitrogen application as a climate change adaptation strategy - appears absolutely disastrous. It is very well-known that one of the most prolific and widespread environmental and water quality problems worldwide is eutrophication and other problems due specifically to excessive fertilizer (nitrogen) application. At an absolute minimum, some strong qualifying statements appear to be required here. It would seem very bad form for an IPCC report to recommend tackling one globally crucial environmental problem (climate change) by exacerbating another (nitrogen pollution). (Fleming, Sean, Meteorological Service of Canada)
654	3	22	33	23	2	The many new lakes forming in deglaciating mountain ranges offer new possibilities for hydropower generation (Terrier, S., Jordan, F., Schleiss, A.J., Haeberli, W., Huggel, C. and Künzler, M. (2011): Optimized and adapted hydropower management considering glacier shrinkage scenarios in the Swiss Alps. Proceedings of the International Symposium on Dams and Reservoirs under Changing Challenges - 79th Annual Meeting of ICOLD, Swiss Committee on Dams, Lucerne, Switzerland (Schleiss, A. & Boes, R.M., Eds), Taylor & Francis Group, London, 497 - 508. (Haeberli, Wilfried, University of Zurich)
655	3	22	33	23	2	According to some studies the potential of hydropower associated to irrigation channels is 1.600 MW, which could allow the building of small-scale run-of projects taking advantage of the topography of the country, which would constitute an adaptation measure and a contribution to the diversification of the energy matrix with non-conventional renewable energies (CHILE)

#	Ch	From Page	From Line	To Page	To Line	Comment
656	3	22	33	23	8	Again this section is rather weak and seems almost exclusively focused on the developed world, despite the clear signals from developing countries (and most acutely in parts of Asia) are facing major problems in securing sufficient water for energy. I would have expected more discussion on water and energy needs will be balanced in fast growing economies and the potential adverse impacts on hydropower development from climate change in India, China and wore widely on continental West, South, South-East, East and Central Asia. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
657	3	22	35	22	36	Large amounts of water are required in the hydraulic fracturing process used for production of natural shale gas. Another risk is pollution of both groundwater and surface water from the chemicals used in the fracking process. This is an emergent freshwater risk from a climate mitigating form of energy that is not covered in this chapter or other chapters of WG 2. Authors should add discussion of this risk to this chapter. (UNITED STATES OF AMERICA)
658	3	22	35	23	8	underline that the many storage reservoirs have a multi-task character-it affects on possible conflicts beetween different functions (POLAND)
659	3	22	40	0	0	The discussion of hydropower here is quite unsophisticated. The issue of hydropower and climate change implies that storage is good, and more storage is better. It doesn't talk about feedbacks related to diminishing returns related to higher ET rates or the difficulty of managing storage and generation potential with the actual intake valve storage. Increasingly, we can expect dams to diverge from their ambient climate, as is evident in many regions globally. And in many cases they will need serious reoperating in keeping with profoundly altered seasonal/annual flow regime patterns, such as finding that generation rates are much declined. These issues are outlined in Matthews/Wickel/Freeman, 2011, listed above. Moreover, there is no mention of widespread diversion dams, such as run of the river dam, which tend to be smaller but quite widespread in developing countries. These can easily lose their potential from low flows or, in the case of many regions, operators divert all flows during drought periods, effectively killing rivers for long stretches. Sediment should also be a critical topic here. We don't know a lot about how sediment erosion patterns will alter, but the implications for hydro generation are very important to storage, operational lifetime, and turbine efficiency. Increased and more intense precip are very important impacts that seem based on first principles alone likely to alter sediment loads for hydropower. Some mention of natural storage mechanisms (such as aquifers) or the natural infrastructure that can be a mechanism for retaining water for droughts/storing water for floods may be useful. This has been a focus of Rwanda's hydro work, for instance, around the Rugezi marshlands (https://dl.dropboxusercontent.com/u/3903757/GEF_Rwandan_wetlands_VA_final.pdf), or also see Yu, Jiang, et al., Freshwater Management and climate change adapation, 2009, Climate and Development. (Matthews, John, Conservation Internatonal)
660	3	22	44	22	46	The timeframe for the decrease to 90% should be clarified. (Mach, Katharine, IPCC WGII TSU)
661	3	22	47	22	47	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
662	3	22	48	22	49	This makes ... ecosystems: I do not understand completely what you would like to say with this sentence... Do you mean that energy availability will be bigger when demand will be bigger? Also you have evidenced that this is just valid for sweden, but despite the importance of Sweden this could be considered as representative just of the northern Europe (maybe Siberia excluded...). (Cassardo, Claudio, University of Torino)
663	3	22	49	0	0	The line here about decreased storage capacity ultimately benefitting ecosystems is crazy; it reads as if it were written by the commercial hydro industry. It cannot be substantiated and will inflame serious ecological ire. I suggest deleting it. (Matthews, John, Conservation Internatonal)

#	Ch	From Page	From Line	To Page	To Line	Comment
664	3	22	49	22	50	Statement starting with "This makes the annual hydrograph..." seems very naive, ignoring the complex dynamics of electricity free markets and regional or larger-scale distribution systems. Suggest softening the wording, and finding other examples of how climate change, hydrology, and hydroelectric generation may intertwine. One good place to look is the Columbia Basin, which has come under intensive study over the last few years due to upcoming questions around the Columbia River Treaty, which governs international joint (Canada-US) management of the basin. (Fleming, Sean, Meteorological Service of Canada)
665	3	22	50	22	51	Additional references for the need to adapt operating rules are Paiva et al. (2010) and Hendrickx and Sauquet (2013), with a case study of the Ariège catchment in the French Pyrenees. - Hendrickx, F. and Sauquet, E. (2013) Impact of warming climate on water management for the Ariège River basin (France). Hydrological Sciences Journal, 58(4), 1-17. doi: 10.1080/02626667.2013.788790 - Paiva, R., Collischonn, W., Schnetterling, E. B., Vidal, J.-P., Hendrickx, F., and Lopez, A. (2010) The Case Studies. Chapter 6 in Modelling the impact of climate change on water resources [Fung, F.; Lopez, A. & New, M. (ed.)], Wiley-Blackwell, Chichester, UK. - 2013 (Vidal Jean-Philippe Irstea)
666	3	23	1	23	2	Typo - This sentence should read: "Storage capacity expansion would help increase hydropower generation but might not be cost-effective. " (Lane, Tracy, International Hydropower Association (IHA))
667	3	23	2	0	0	Should this paragraph also include some information on considerations related to public/socio-environmental acceptance of constructing more reservoirs? (CANADA)
668	3	23	2	23	2	Replace "costed" with word "cost" (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
669	3	23	2	23	2	It is strongly recommended to add the following: In snow dominated regions the need for storage capacity is expected to be reduced as lower inflow in summer and higher in winter will drastically reduce the need to transfer water from summer to winter when production is needed (Golombek et al., 2012) Golombek, R., Kittelsen, S.A.C., and Haddeland, I. (2012), Climate change: impacts on electricity markets in Western Europe, Climatic Change, 357-370, doi:10.1007/s10584-011-0348-6. (Hisdal, Hege, Norwegian Water Resources and Energy Directorate)
670	3	23	4	23	6	Regarding water availability for cooling of... increased stream temperatures and occurrence of low flows (van Vliet et al., 2012). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
671	3	23	6	23	7	Lower ... change: what is the connection of this sentence with the others? Where this fact is mentioned in Tab. 3-2? I did not find any reference about. I think it should be better to reference the paper also in the text. (Cassardo, Claudio, University of Torino)
672	3	23	11	23	37	Why is the title for this section 'Municipal services'? And why is the text focused solely on supply to urban areas? The issues are as important for rural areas and in developing countries these are likely to be at significant threat. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
673	3	23	11	24	19	In this point 3.5.2.3 Municipal Services taking into account the problems with water availability in the present and the future, I think that is necessary write as a main adaptation measure the reuse of treated wastewaters . This is put as adaptationmeasure in Table 3.3 but not explained neither developed (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
674	3	23	13	0	0	Desal is a strange absence here, considering that desal is already going to scale in California and across the Gulf States and that some regions such as the Maghrib are making explicit investment choices already between desal for drinking water and irrigation. Holger Hoff at SEI is doing some of this in the Med/North Africa region, for instance. The potential for mitigation-adaptation conflict is all ove these suggestions, but is not mentioned. Countries will need to decide how to prioritize and sort through these issues. This simple insight is deeply ignored. (Matthews, John, Conservation International)

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675	3	23	13	23	13	water utilities are confronted by the following: what it does mean this? Which one is the subject and which one the object? (Cassardo, Claudio, University of Torino)
676	3	23	13	23	16	It may be much clearer for the reader if the relevant citations were placed after each bullet. (Mach, Katharine, IPCC WGII TSU)
677	3	23	17	23	21	Please change as "Both impacts are..." and "higher ambient temperatures are..." (Ambulkar, Archis, Brinjac Engineering Inc.)
678	3	23	17	23	43	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present levels of confidence for some or all of these statements, instead of likelihood terms. Additionally, all likelihood terms retained should be italicized for clarity, and otherwise, casual usage of the reserved likelihood terms should be avoided. (Mach, Katharine, IPCC WGII TSU)
679	3	23	17	24	19	Higher ambient temperatures is very likely to... (low to medium confidence, limited evidence) (Seidu et al., 2013). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
680	3	23	18	23	18	change "is" with "are" (Cassardo, Claudio, University of Torino)
681	3	23	18	23	18	The point made here around evaporation and aquifers might benefit from some refinement. Aquifers may be depleted due to higher evaporation rates, but in general, only indirectly - due to decreased infiltration to the saturated zone under increased ET losses in the uppermost soil column, or due to increased pumping of groundwater to compensate for increased evaporative losses or consumption elsewhere. Direct evaporation from aquifers is generally minimal, as evaporative loss rates decrease very quickly with depth. Some detailed fact-checking would appear in order here. (Fleming, Sean, Meteorological Service of Canada)
682	3	23	18	23	18	impacts are (ITALY)
683	3	23	19	23	19	change "is" with "are" (Cassardo, Claudio, University of Torino)
684	3	23	22	0	0	Suggest changing to "shifts in TIMING of river flow" (CANADA)
685	3	23	22	23	22	Authors should replace "occurrence of droughts" with "amplification of drought intensity with warmer temperatures." (UNITED STATES OF AMERICA)
686	3	23	24	23	25	Please change as "algal blooms in surface water will potentially demand for..." (Ambulkar, Archis, Brinjac Engineering Inc.)
687	3	23	25	0	27	Sentence is difficult to understand. Suggest clarifying. (CANADA)
688	3	23	26	0	0	Please change as "that are responsible for disinfection by-products..." (Ambulkar, Archis, Brinjac Engineering Inc.)
689	3	23	30	23	32	It is not clear why the authors consider natural chemical contaminants will be further affected by climate change - is it because they consider it is more likely that contaminated water sources will be used as other sources become less secure (e.g. shallow groundwater in Bangladesh). This is a very contestable statement and one for which there is limited evidence. This sentence should be far more nuanced. Also, can the authors make sure that they are accurate when describing occurrence of major contaminants - e.g. arsenic is found through West, South, South East and East Asia (China has by far the largest number of identified cases). The current text is inaccurate. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
690	3	23	31	0	0	Should the sentence be "in areas already affected from including..." (Ambulkar, Archis, Brinjac Engineering Inc.)
691	3	23	31	23	31	Suggest replacement of 'from' with 'including' (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
692	3	23	33	23	35	It should be noted the inability of the municipal drainage systems to store and/or route the increased storm runoff and peak flows (Due to changes in frequency and magnituded of the storm rainfall-runoff events), although it is presented at the following paragraphs.(Athanasios Loukas, Civil Engineering Department, University of Thessaly, Greece) (GREECE)
693	3	23	33	23	35	Not clear why increased water-borne pathogen loading would render existing indicators obsolete. An explanation and literature citations are required. (Fleming, Sean, Meteorological Service of Canada)
694	3	23	33	23	35	The bullet point on the inadequacy of faecal indicators because of changes in storm frequency is highly misleading and inaccurate. There are well known flaws to the currently used indicators that led to the change in the approach recommended for managing water safety in the WHO Guidelines for Drinking Water Quality to a more risk based approach. It is simply incorrect to say climate change impacts will have any significant impact on the adequacy of indicators already known to have weaknesses. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
695	3	23	34	0	0	Please change "The indicators traditionally used.... are likely to be insufficient..." (Ambulkar, Archis, Brinjac Engineering Inc.)
696	3	23	35	23	35	change "is" with "are" (Cassardo, Claudio, University of Torino)
697	3	23	39	23	46	This text is poor and only deals with one aspect of water supply - water treatment. Even in its handling of this it focuses solely on coagulation dosages required and makes no attempt to consider the impacts on multi-stage filtration more commonly used in developing countries. There is no discussion of the impact of piped distribution systems which will become more vulnerable, nor of the risks to non-piped supplies. No discussion is included on the importance of management models to manage risks and reduce vulnerability. No reference is made to literature dealing with climate change in developing countries - for instance Howard et al (2010) Journal of Climate Change in Water 1:2-16 gives an overview of global risks. The authors could also refer to the World Bank paper on utilities and climate change (Danilenko et al 2010). (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
698	3	23	40	23	40	Replace the acronym DJF by its meaning (December, January and February?) (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
699	3	23	40	23	40	after plants add in brackets : "(specially small ones)" (POLAND)
700	3	23	40	23	41	When describing "extreme influent variations...", it would be helpful to list and identify the parameters (such as turbidity, organic content, temperature, etc.) (Ambulkar, Archis, Brinjac Engineering Inc.)
701	3	23	41	23	42	The sentence might need to be revised as "infrastructure for treatment with periods ranging from one month to up to several months per year" (Ambulkar, Archis, Brinjac Engineering Inc.)
702	3	23	42	0	0	Start sentence "For example, in order to merely...." (Ambulkar, Archis, Brinjac Engineering Inc.)
703	3	23	45	0	0	Please add a comma as "impacts and local conditions, resulting costs..." (Ambulkar, Archis, Brinjac Engineering Inc.)
704	3	23	45	23	46	Is this last sentence a little alarmist? The alternative is no clean water supply - a situation unlikely to happen(?) (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
705	3	23	48	24	19	This text is also rather weak. It only focuses on conventional sewerage and does not address the issues of on-site sanitation or non-conventional sewerage. The Howard et al reference noted above also covers sanitation. It does not discuss impacts on treatment or treatment technology selection and the impact this may have on emissions. Most of the text is only relevant to developed countries and very limited areas of developing countries. The final statement that the disposal of faecal sludge or wastewater in developing countries is only just beginning to be studies is highly misleading and inaccurate - it is very widely studied and it strikes me the authors have made little attempt to look at this literature. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
706	3	23	50	23	50	It would be preferable to place the citations with the relevant bullets. (Mach, Katharine, IPCC WGII TSU)
707	3	23	54	0	0	Please add a comma as "In addition, new strategies..." (Ambulkar, Archis, Brinjac Engineering Inc.)
708	3	23	54	23	54	Use of "must be" would preferably be avoided to ensure the statement is not prescriptive. (Mach, Katharine, IPCC WGII TSU)
709	3	24	0	0	0	Considering the effects of heavy rainstorms and storm runoff, should any discussion be needed to reflect the need for separation of storm sewers from sanitary sewers. This would reduce the hydraulic as well as organic loads on wastewater treatment plants. (Ambulkar, Archis, Brinjac Engineering Inc.)
710	3	24	0	24	0	General comment - Section 3.5.2.4:\n(1) This section does not seem to be appropriately categorised as "Water Uses" but a more general sectoral impact.\n(2) Water-related climate change impacts may also directly/indirectly affect terrestrial ecosystems, changing predation characteristics, wildfires, human health (e.g. water-borne diseases) and others - discussions on these are missing. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
711	3	24	1	24	0	This section does not seem to be appropriately categorised as "Water Uses" but a more general sectoral impact. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
712	3	24	1	24	0	Water-related climate change impacts may also directly/indirectly affect terrestrial ecosystems, changing predation characteristics, wildfires, human health (e.g. water-borne diseases) and others - discussions on these are missing. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
713	3	24	5	0	0	It should be either "soils shrink as they lose" or "soil shrinks as it loses" (Ambulkar, Archis, Brinjac Engineering Inc.)
714	3	24	5	24	5	change "they" with "it" (Cassardo, Claudio, University of Torino)
715	3	24	9	24	9	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
716	3	24	12	24	12	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
717	3	24	15	24	15	Casual usage of "unlikely" should be avoided, as it is a reserved likelihood term. Additionally, further detail on what is meant by "feasible" could be helpful. (Mach, Katharine, IPCC WGII TSU)
718	3	24	18	24	19	Just beginning to be studied in terms of climate change impacts, yes? Please be specific and clear. (Fleming, Sean, Meteorological Service of Canada)
719	3	24	19	24	19	It would be preferable to also specify a summary term for agreement here, following the guidance for authors. (Mach, Katharine, IPCC WGII TSU)
720	3	24	22	24	22	It might be worth including here the consequences to freshwater ecosystems of adaptation strategies to secure water supply (increased dam building). You could also cross reference to 4.3.3.3. (Bunn, Stuart, Griffith University)
721	3	24	24	24	40	that part needs wider elaboration with divisions among different regions (POLAND)
722	3	24	29	24	50	Climate change is an additional stressor... 2009; Hsiang et al., 2011). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
723	3	24	33	24	34	It could be helpful to qualify further what is meant by "endangered by extinction"--where, to what extent, etc. (Mach, Katharine, IPCC WGII TSU)
724	3	24	33	24	35	The work of Zacharias and Zamparas, 2010 on Mediterranean pools has been poorly described. The relative magnitude of threats identified by the authors has not been adequately explained. (AUSTRALIA)
725	3	24	33	24	35	Which category of wetland was being studied (i.e location) as the study might not reflect the wetlands in general (MALAYSIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
726	3	24	37	24	40	This comment only holds true is flood management is infrastructure based, but if integrated approaches are taken and environmental measures used it is not automatic that ecosystems will suffer. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
727	3	24	38	24	38	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
728	3	24	47	24	50	There are other points of view that suggest risks of violent conflict from water scarcity may actually avoided in lieu of more peaceful cooperation or are not as risky as some indicators would indicate (e.g., Wolf et al., 2003, Water Policy, 5 29; Jarvis et al., 2005, Ground Water, 43(5), 764; De Stefano et al., 2012, Journal of Peace Research, 49(1), doi: 10.1177/0022343311427416). Authors should acknowledge this body of literature and balance the language in this paragraph to explain that water is also often a tool for peace. (UNITED STATES OF AMERICA)
729	3	24	47	24	50	It would be useful to clarify that conflicts over water are likely to occur within nations and the evidence suggests that inter-state conflict remains relatively unlikely, and to date has not really occurred (the authors could usefully look at work from the team at Oregon University (Aaron Wolf) on international water conflicts. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
730	3	24	48	24	49	This statement must be coordinated with the key findings of chapters 12 and 19, as it does not seem consistent with their assessments. (Mach, Katharine, IPCC WGII TSU)
731	3	24	52	25	2	This section puzzlingly ignores many of the seminal papers in the area, such as by Carmen de Jong. I can send a list if you wish. (Matthews, John, Conservation International)
732	3	24	53	24	53	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
733	3	25	0	26	0	General comment - Section 3.5.3:\n(1) This section has focused on extreme precipitation/floods; drought-related damages are not explicit or missing.\n(2) It is also worth mentioning other direct, indirect, intangible, environmental and social costs, e.g. loss of ecosystem services, agricultral land, health care, disaster and emergency response and recovery costs etc. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
734	3	25	1	25	2	What are the impacts on tourism referred? Are these likely to get worse or get better? (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
735	3	25	7	25	8	It would be helpful to specify how much variability there is year-to-year in reported damages. (Mach, Katharine, IPCC WGII TSU)
736	3	25	7	26	0	This section has focused on extreme precipitation/floods; drought-related damages are not explicit or missing. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
737	3	25	8	0	0	Should it be "to about 24 billion US\$ per year in 2011..." (Ambulkar, Archis, Brinjac Engineering Inc.)
738	3	25	9	25	9	The relevant finding from the special report on extremes was broader than flood disaster losses, which should be reflected appropriately here. (Mach, Katharine, IPCC WGII TSU)
739	3	25	14	25	14	I would add that it is expected that this increase in the population living in flood prone areas, mainly those located neas the coast, will continue in the future. See for instance Llasat et al, 2008, or the "Plan Bleu (France)", or the European Flood Directive . Reference: Llasat, M.C., L. López, M. Barnolas and M. Llasat-Botija, 2008: Flash-floods in Catalonia: the social perception in a context of changing vulnerability. Advances in Geosciences, 17 , 63-70. (Llasat, Maria-Carmen, University of Barcelona)
740	3	25	17	0	0	Needs to remove "are" from sentence as "with the highest number (75%) concentrated in..." (Ambulkar, Archis, Brinjac Engineering Inc.)

#	Ch	From Page	From Line	To Page	To Line	Comment
741	3	25	26	25	26	change "detail" in "detailed" (Cassardo, Claudio, University of Torino)
742	3	25	26	25	29	Wording is quite bad, I'm afraid - the passage is almost unintelligible. (Fleming, Sean, Meteorological Service of Canada)
743	3	25	28	25	28	require (ITALY)
744	3	25	33	0	0	Sentence needs revision as "as they are not...." (Ambulkar, Archis, Brinjac Engineering Inc.)
745	3	25	33	0	33	they (ITALY)
746	3	25	34	25	34	To support this statment about the inclusion of local or regional events in national or global databases, I propose the reference Llasat et al, 2013, that shows a comparison between different flood data bases. Reference: Llasat, M. C., Llasat-Botija, M., Petrucci, O., Pasqua, A. A., Rosselló, J., Vinet, F., Boissier, L., 2013. Towards a database on societal impact of Mediterranean floods in the framework of the HYMEX project. Nat. Hazards Earth Syst. Sci., 13, 1–14, 2013. www.nat-hazards-earth-syst-sci.net/13/1/2013/ doi:10.5194/nhess-13-1-2013; (Llasat, Maria-Carmen, University of Barcelona)
747	3	25	34	25	36	I understand what authors will say, but it is not clear as it is written: please rephrase this sentence. (Cassardo, Claudio, University of Torino)
748	3	25	35	0	0	Sentence needs revision as "even small floods have...." (Ambulkar, Archis, Brinjac Engineering Inc.)
749	3	25	45	25	47	For this projection, it would be helpful to specify the relevant time frame. (Mach, Katharine, IPCC WGII TSU)
750	3	25	48	0	48	related (ITALY)
751	3	25	51	0	0	Sence needs full stop "expected losses." (Ambulkar, Archis, Brinjac Engineering Inc.)
752	3	25	53	0	54	Suggest specifying region associated with this finding. (CANADA)
753	3	25	53	0	54	where those restrictions were implemented? what is the reference? (ITALY)
754	3	25	53	25	53	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
755	3	25	53	26	3	This paragraph on costs of inland waterway transport does not seem to fit within section 3.5.3 which focuses on hundreds of millions of people being exposed to flood risk with billion pound costs. Suggest deleting this paragraph. (AUSTRALIA)
756	3	26	1	26	2	Sentence needs revision as "high water levels in rivers are likely to increase...." (Ambulkar, Archis, Brinjac Engineering Inc.)
757	3	26	2	26	2	change "increasing" in "increase" (Cassardo, Claudio, University of Torino)
758	3	26	2	26	2	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
759	3	26	6	26	14	As part of measures to adapt to climate change and risk management, Chile has a national irrigation strategy, whose objectives are to expand the irrigated area, the promotion of technologies and efficient management, and the promotion of efficient and modern Water Users Organizations. Also the incorporation of multisectoral management that would ensure water availability for all economic sectors. The plan is based on two main pillars, which are infrastructure construction and management of user organization (CHILE)
760	3	26	8	26	8	remove "the" before "changes" (Cassardo, Claudio, University of Torino)
761	3	26	9	0	0	Sentence needs revision as "there is a need...." (Ambulkar, Archis, Brinjac Engineering Inc.)
762	3	26	9	26	10	This is a poorly drafted sentence, consider revising. (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
763	3	26	10	0	0	Sentence needs revision as "positive impacts, there is a need...." (Ambulkar, Archis, Brinjac Engineering Inc.)
764	3	26	17	0	0	This section is remarkably out of date. There is no recognition of recent approaches or insights and problems. Some of the papers have weathered somewhat well (Sadoff and Muller, for instance). But most have not. A central problem around water is the conflict between the need for precise, accurate information about eco-hydrological information many decades from now and the utter inability to provide that information. Easily the most inciteful essay on this is Casey Brown's The End of Reliability, but there are a variety of works by Brown, Wilby, Dessai, and others that have a lot of insight into the special problems around water management. Climate change is not relevant to every part of water management, but it is relevant to a large part of it. It might also be worth pointing out that the argument that Parmesan et al. 2011 use in Overastrecting Attribution beautifully transfers over to water problems. It is very easy to get obsessed as KfW, GiZ, and the GEF have about "documenting" real or potential impacts that assumes that we can easily define in terms of infrastructure, institutions, information, etc., the "additionality" of climate adaptation options. Perhaps this works in terrestrial problems but I doubt it. There is no way that it works in freshwater areas. The material on IWRM needs to be completely removed. There is nothing inherent to IWRM that makes it particularly suitable or unsuitable for climate adaption. Eflows is arguably better as a general methodology, and it also lacks any clear connection to climate processes. This thinking is not in the mainstream. Moreover, approaches that claim to be no-regret are also quite awful. Infrastructure is an inherently regretful decision making process. I would argue that climate change offers fundamental challenges to the way we have been managing water, and that we need to make some major shifts, such as development as a proces rather than building or developing all at once, and becoming (in Brown's phrase) robust to multiple options. This is clearly described in Le Quesne et al. 2010 Flowing Foward and in Matthews/Wickel/Freeman 2011. I would consider including some of the references in the Nairobi Work Pogramme briefing on water and climate that was published anonymously but was actually written by David Purkey from SEI and is actually quite good in describing these issues. It came out in 2012, a few months before the COP and is on the NWP site. (Matthews, John, Conservation Internatonal)
765	3	26	17	27	8	This section does not talk at all about adaptation in domestic water and sanitation services - there is literature available on this and I would have expected at least some discussion of this (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
766	3	26	19	26	19	Change "3rd IPCC" to "Third IPCC" - in line with Page 4 Line 46. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
767	3	26	19	26	20	Sentence needs revision as "in the water sector, many of them...." (Ambulkar, Archis, Brinjac Engineering Inc.)
768	3	26	21	26	21	Here, it may be preferable to refer to "low regret" actions in place of "no regret" actions. (Mach, Katharine, IPCC WGII TSU)
769	3	26	21	26	22	Sentence needs revision as "as "no regret actions" (which are the actions....economic benefits) can be implemented..." (Ambulkar, Archis, Brinjac Engineering Inc.)
770	3	26	25	26	27	In Table 3.3 Categories of climate change adaptation measures regarding to freshwater - I suggest add other measures of adaptation that maybe useful as collect ("harvest ") of rain waters but without adequate technological means, and the "harvest " of dew waters utilized in countries with year small precipitation average as Peru in Latin America, both utilized in different developing countries. Both measures not are expensive and could be expanded. (DIAZ MOREJON, CRISTOBAL FELIX, Ministry of Science, Technology and the Environment)
771	3	26	26	26	27	Table 3 is drawn from a highly selective set of references some of which do not directly address climate change. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)

#	Ch	From Page	From Line	To Page	To Line	Comment
772	3	26	29	26	33	Adaptation Strategies for for mainstream in the middle reaches of Yellow River under Climate Change is highly discussed in paper "A Strategy to Deal with Water Crisis under Climate Change for mainstream in the middle reaches of Yellow River", we add this reference (Wang et al., 2011) to support adaptation. \nWang, X.J. Zhang, J.Y.He, R.M. et al., 2011: A Strategy to Deal with Water Crisis under Climate Change for mainstream in the middle reaches of Yellow River, Mitigation and Adaptation Strategies for Global Change, 2011, 16?5?: 555-565? (Wang, Guoqing, Nanjing Hydraulic Research Institute)
773	3	26	29	26	40	Adaptation measures, which involve a combination of... externalities in the pricing of exports. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
774	3	26	29	26	49	It would be preferable to provide much more nuance in the examples used here. (Mach, Katharine, IPCC WGII TSU)
775	3	26	35	26	35	results, i.e. (ITALY)
776	3	26	37	0	37	incerease (ITALY)
777	3	26	38	26	39	Wording requires improvement and clarification. Also, please define "virtual water." (Fleming, Sean, Meteorological Service of Canada)
778	3	26	38	26	40	This appears to be a throw-away statement on the use of virtual water. How would its use prevent maladaptation? It is far from clear from the material here that it could possibly achieve this. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
779	3	26	44	0	44	IWRM is an interantioanlly accepted approach: many references contraddict this (ITALY)
780	3	26	51	26	53	adaptations are best archieved through mainstreaming... and treating them separately (Elasha, 2008). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
781	3	27	0	28	0	General comment - Section 3.6.3:\nIt is worth mentioning the importance of identifying "critical thresholds" of a system, e.g. see "Weiß, M., and J. Alcamo (2011), A systematic approach to assessing the sensitivity and vulnerability of water availability to climate change in Europe, Water Resour. Res., 47, W02549." (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research. University of East Anglia)
782	3	27	1	28	0	It is worth mentioning the importance of identifying "critical thresholds" of a system, e.g. see "Weiß, M., and J. Alcamo (2011), A systematic approach to assessing the sensitivity and vulnerability of water availability to climate change in Europe, Water Resour. Res., 47, W02549." (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
783	3	27	5	27	8	Integrating water resources management... priority in water management aspects. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
784	3	27	11	0	0	Section 3.6.2. The title of this section should be considered, given that it assesses barriers to adaptation within the paragraph, which are distinct from limits to adaptation. (Mach, Katharine, IPCC WGII TSU)
785	3	27	11	27	23	This section is very brief and, for instance, suggests that poor people settling in unsafe areas is a major barrier - but in fact the same is certainly true of the rich who tend to demand higher quality and more expensive services and who through their use of resource impose limits on poor people's adaptation. For instance, the impact of the floods in Pakistan were in part caused by the resistance from wealthy landowners to allow flooding of their land, leading directly to flooding and damage of land and assets used by the poor. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
786	3	27	15	0	0	Please add a comma as "communication, etc..." (Ambulkar, Archis, Brinjac Engineering Inc.)
787	3	27	15	27	23	Some of the barriers that are of... required for food and energy production. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
788	3	27	16	27	16	Cultural aspects are also important and should not be omitted, even if literature may be limited. The complexity and interlinkages between the technical, socio-economic and cultural issues need to be highlighted. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
789	3	27	16	27	16	Cultural aspects are also important and should not be omitted, even if literature may be limited. The complexity and interlinkages between the technical, socio-economic and cultural issues need to be highlighted. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
790	3	27	17	26	17	add something about saving water: saving water als means also energy because acquiring, transporting and prcessing the water needs huge energy costs. Therefore the improvement of managing demand for water is very important. Water as energy, is essential for human activity as well as for economic activity (POLAND)
791	3	27	22	0	0	Sentence needs revision as "customary; and (e)...." (Ambulkar, Archis, Brinjac Engineering Inc.)
792	3	27	22	27	22	change "sources" in "resources" (Cassardo, Claudio, University of Torino)
793	3	27	26	0	0	Section 3.6.3. For this section, the chapter team should ensure that the focus throughout is on freshwater resources. For example, it would be helpful to clarify what type of freshwater impact is relevant for the example given on lines 33-35 on page 27. (Mach, Katharine, IPCC WGII TSU)
794	3	27	26	27	26	in title: "uncertainty": of what? (Cassardo, Claudio, University of Torino)
795	3	27	26	28	28	I suggest to add a description of the impact response surface approach that has been applied with hydrological and permafrost models (Fronzek et al. 2010, Applying probabilistic projections of climate change with impact models: a case study for sub-arctic palsa mires in Fennoscandia, doi:10.1007/s10584-009-9679-y; Fronzek et al. 2011, Evaluating sources of uncertainty in modelling the impact of probabilistic climate change on sub-arctic palsa mires, doi:10.5194/nhess-11-2981-2011; Weiss 2011, Future water availability in selected European catchments: a probabilistic assessment of seasonal ?ows under the IPCC A1B emission scenario using response surfaces doi:10.5194/nhess-11-2163-2011; Wetterhall et al. 2011, Using ensemble climate projections to assess probabilistic hydrological change in the Nordic region, doi:10.5194/nhess-11-2295-2011). In that approach, an impact model's sensitivity to changes in key climate variables (in these examples change in annual surface temperature and precipitation) is conducted and plotted as a surface showing an impact variable against temperature change on the one axis and precipitation change on the other. This can both be combined with probabilistic projections of climate change and to identify optimal adaption options in a bottom-up approach (Brown et al. 2011. A Decision-Analytic Approach to Managing Climate Risks: Application to the Upper Great Lakes, doi:10.1111/j.1752-1688.2011.00552.x). The same approach of constructing response surfaces has also been used by Prudhomme et al. (2010), which is mentioned on page 14, line 4, however, not in the context of uncertainty. (Fronzek, Stefan, Finnish Environment Institute)
796	3	27	33	27	45	In the recent publication of "Quantifying Uncertainty in Catchment-scale Runoff Modeling under Climate Change (Case of the Huaihe River, China)", it argued that "As there are not enough probabilistic climate change scenarios or multiple runs, it is difficult to assess any likelihood of a particular projection. Ensemble analysis could be a resonable approach." As a study case to argue the idea of "produce liklihood distributions of impacts", the work could be refrenced in LINE 35, which could be changed as "...which use very large numbers of scenarios to produce..., but argued that which is large enough to form distribution(Liu et al,2012)". Liu, Y., Zhang, J., Wang, G., Liu, J., He, R., Wang, H., Liu, C. and Jin, J., 2012: Quantifying \nUncertainty in Catchment-scale Runoff Modeling under Climate Change (Case of the Huaihe \nRiver, China), Quaternary International, 282:130-136. (Wang, Guoqing, Nanjing Hydraulic Research Institute)

#	Ch	From Page	From Line	To Page	To Line	Comment
797	3	27	34	27	36	Two other examples of probabilistic hydrological impact assessments which could be mentioned here have been provided by Weiss (2011, doi:10.5194/nhess-11-2163-2011) and Wetterhall et al. (2011, doi:10.5194/nhess-11-2295-2011). An example for impacts on permafrost (also covered in this chapter) has been presented by Fronzek et al. (2011, doi:10.5194/nhess-11-2981-2011). (Fronzek, Stefan, Finnish Environment Institute)
798	3	27	34	27	45	I suggest to add that probability distributions of impacts are usually conditional on a number of assumptions, e.g. the forcing scenario used to project future climate and specific assumptions made in the impact analysis. Ideally this should be (and I would argue most studies have done that) clearly communicated when presenting a probability distribution of an impact variable. Mentioning this would give a better context for the criticism of probabilistic approaches summarized in the latter part of this paragraph. (Fronzek, Stefan, Finnish Environment Institute)
799	3	27	36	27	45	The use of multiple scenarios... less literal interpretation of scenario results. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
800	3	27	38	27	38	cross reference to be completed (ITALY)
801	3	27	38	27	38	A cross-reference should be supplied here, noting that there's not a single chapter that could be described as the scenario chapter. (Mach, Katharine, IPCC WGII TSU)
802	3	27	42	0	42	omit "and others" (ITALY)
803	3	27	45	0	45	less literal interpretation of scenario results: unclear (ITALY)
804	3	27	47	0	53	the concept of methods and models are mixed and therefore the overall meaning of the paragraph is unclear. (ITALY)
805	3	27	47	27	52	The authors may be citing editorial opinions about this issue rather than studies showing results that expand understanding on this issue. There may be editorial viewpoints included in the citations list of this statement. Authors should review the narrative in their citations. For citations that offer editorial views and no analysis related to this issue, it would be best to instead reference the citations that supported the editorial view (i.e., Do Lins and Cohn 2011 or Stakhiv 2011 do original analysis to support this view? If not, then do they cite other studies that showed results leading to this view? if yes, then cite those studies rather than Lins and Cohn 2011 or Stakhiv 2011.) (UNITED STATES OF AMERICA)
806	3	27	47	28	2	I welcome the new paragraph which is in accord to what I had suggested. I think its addition is a step toward more balanced presentation of the literature. A minor point: Lins and Cohn (2011) appears twice in the paragraph but I think this is an error. Its first appearance should be deleted (it is out of context), while the second is fine. (Koutsoyiannis, Demetris, National Technical University of Athens)
807	3	27	47	28	2	A relevant study may be Raff et al., 2009 (doi:10.5194/nhess-13-2119-2009) who discuss the benefits of using climate projections compared to using only flow observations (what they call the expanding retrospective). A key question in this respect is if changes in (especially) the probability of extreme events can be identified *before* they become apparent in the flow record, because by then it is obviously too late. (Dankers, Rutger, Met Office Hadley Centre)
808	3	28	0	29	0	General comment - Section 3.6.5: It is worth highlighting that costs would depend on local, regional, national circumstances, e.g. institutional and socio-economic structures. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
809	3	28	1	29	0	It is worth highlighting that costs would depend on local, regional, national circumstances, e.g. institutional and socio-economic structures. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
810	3	28	1	29	0	Discussion non-monetary and intangible costs are missing, e.g. stress on communities due to forced migration. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
811	3	28	3	28	3	I reiterate my earlier comment on the discussion of the IPCC AR4 report (chapter on Freshwater), which is very relevant to uncertainty, the subject of this section. I suggest to refer to it by adding the following paragraph: “Uncertainty was the central issue of an extended discussion (Koutsoyiannis et al., 2009; Kundzewicz et al., 2009) as a follow up of a summary of the corresponding Freshwater Chapter of the IPCC AR4 (Kundzewicz et al., 2008). Koutsoyiannis et al. (2009) imply that the climate system and particularly its components related to freshwater are fundamentally unpredictable, and that hydrologists and water managers should give more emphasis on understanding and modeling the uncertainty per se, rather than relying on hopeless deterministic projections. On the other hand, Kundzewicz et al. (2009) argue that scenarios of the future which present plausible futures of climate are necessary for supporting present-day decisions with respect to mitigation of and adaptation to climate change in the water sector.” References to be added Koutsoyiannis, D., A. Montanari, H. F. Lins, and T.A. Cohn, Climate, hydrology and freshwater: towards an interactive incorporation of hydrological experience into climate research—DISCUSSION of “The implications of projected climate change for freshwater resources and their management”, Hydrological Sciences Journal, 54 (2), 394–405, 2009. Kundzewicz, Z. W., L. J. Mata, N. W. Arnell, P. Döll, B. Jimenez, K. Miller, T. Oki, Z. ?en and I. Shiklomanov, The implications of projected climate change for freshwater resources and their management, Hydrological Sciences Journal, 53(1), 3–10, 2008. Kundzewicz, Z. W., L. J. Mata, N. W. Arnell, P. Döll, B. Jimenez, K. Miller, T. Oki and Z. ?en, Water and climate projections—Reply to discussion “Climate, hydrology and freshwater: towards an interactive incorporation of hydrological experience into climate research”, Hydrological Sciences Journal, 54(2), 406–415, 2009. (Koutsoyiannis, Demetris, National Technical University of Athens)
812	3	28	4	28	28	Addressing the effects of uncertainty through its... wide range of potential disruptions. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)

#	Ch	From Page	From Line	To Page	To Line	Comment
813	3	28	4	28	28	Suggestions for additions from Willems et al., 2012: o The large uncertainties that currently exist should not be an argument for delaying climate change impact investigations or adaptation actions. Instead, uncertainties should be accounted for and flexible and sustainable solutions aimed at. An adaptive approach has to be established that both provides inherent flexibility and reversibility and also avoids closing off options. This is different from the traditional engineering approach, which is rather static and is often based on design rules set by engineering communities without much public debate.\no This adaptive approach involves active learning, hence recognizing that flexibility is required as understanding increases.\no And from Willems & Arnbjerg-Nielsen, 2013: In the presence of climate change induced uncertainty, urban water systems also need to be more resilient and multi-sourced. An adaptive approach has to be established that both provides inherent flexibility and reversibility and also avoids closing off options. This is different from the traditional engineering approach, which is rather static and is often based on design rules set by engineering communities without much public debate and an ever increasing optimization towards achieving the design criteria. Adaptive approaches mainly originate from the ecological sector where high uncertainties in the knowledge of processes and responses are inherent, even beyond the climate change context. In ecology, traditional engineering design approaches are often not applicable because of scientific uncertainties. This also involves challenging modifications to the roles of the water scientist, the water manager and the water engineer, but also of the property owner and user, the insurer, the city and green area planner, the socio-economist and the politician. Adaptive approaches also involves active learning, hence recognizing that flexibility is required as understanding increases and that solutions must be identified that are good for all stakeholders rather than being the optimal solution for just one stakeholder.\n\nThe higher awareness of future changes hence can be seen as a driver to rethink the concepts of urban drainage. Climate change impacts on precipitation clearly show that a business-as-usual approach is not feasible in many regions of the world. The issues raised here point out that it is in many situations necessary to re-evaluate the entire concept of urban drainage rather than “just” upgrading the technical solutions we have implemented over the last 150 years. It is necessary to establish and maintain hygienic barriers and to build cities that interact with water in a healthy, environmentally friendly, and cost-efficient way. This will in general include the use of sewer systems, but in the future the sewer systems will be part of a greater and more complex infrastructure governing the collection, storage, use, and reuse of water in cities to meet many different objectives that the citizens will all benefit from.\n\nRef: • Willems, P., Arnbjerg-Nielsen, K. (2013), ‘Climate change as a driver for urban drainage paradigm change’, Water21, February 2013, 23-24 (Willems, Patrick, KU Leuven)
814	3	28	6	28	7	cross reference to be completed (ITALY)
815	3	28	6	28	7	The mentioned cross-references must be supplied. (Mach, Katharine, IPCC WGII TSU)
816	3	28	7	28	7	Insert reference Mathison et al. (2012): Camilla Mathison, Andy Wiltshire, Pankaj Kumar, A P Dimri, Jeff Ridley, Daniela Jacob, Pete Falloon, Prof Yasunari, Christian Siderius, Markus Stoffel (2012) Regional Projections of South Asian Climate for Adaptation studies. Science of the Total Environment (accepted) http://dx.doi.org/10.1016/j.scitotenv.2012.04.066 (Falloon, Peter, Met Office Hadley Centre)
817	3	28	7	28	9	The sentence "An example... infrastructure" needs to be rephrased for correct language. (Ambulkar, Archis, Brinjac Engineering Inc.)
818	3	28	10	28	12	The sentence "This combined... disruptions" needs to be rephrased for correct language. Also, it should be "This combined low-regret option" or "These combined low-regret options" (Ambulkar, Archis, Brinjac Engineering Inc.)
819	3	28	19	28	20	There are too many "the" included, please revised the sentence. (Ambulkar, Archis, Brinjac Engineering Inc.)
820	3	28	31	28	48	Authors should add "inter-disciplinary training" to the section on capacity building. (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
821	3	28	31	28	48	This paragraph has a limited view as it only deals with community-based approaches to adaptation and whilst this is important, on larger basins adaptation will also (or primarily) involve other processes where major decisions on infrastructure management and development will be required - there may be local consultation in such decisions but it is unlikely to involve full participatory processes (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
822	3	28	31	28	48	Adaptation measures to climate change should also consider improvements to the management of water resources. In Chile this it is focused through the creation and strengthening of water user organizations, which allows organizations to manage water resources in the most efficient way. Within the areas of management of water user organizations, are; the allocation of the resource among irrigators, maintenance and improvement of its infrastructure and the ensuring of water quality for irrigation, among other function (CHILE)
823	3	28	33	28	34	Please clarify what is meant by increasing vulnerability to climate change--do you mean increasing risks from climate change? (Mastrandrea, Michael, IPCC WGII TSU)
824	3	28	33	28	48	Strengthening the professional capacity... water supply and flood risk (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
825	3	28	37	0	0	The sentence to be revised as "Thus, for implementing..." (Ambulkar, Archis, Brinjac Engineering Inc.)
826	3	28	40	0	0	The sentence to be revised as "so that they will understand..." (Ambulkar, Archis, Brinjac Engineering Inc.)
827	3	28	42	0	0	Capacity building may be hampered by the increased intensity, frequency, and duration of extreme events, as climate change becomes more extensive, and where adaptation measures based on traditional knowledge or extrapolation of historical trends could be largely ineffective. [15.3.2.2] (Backus, George, Sandia National Laboratories)
828	3	28	44	28	44	Following from my overall comment on the chapter's use of calibrated uncertainty language, the chapter team could consider whether it would be preferable to present a level of confidence here, instead of the likelihood term. (Mach, Katharine, IPCC WGII TSU)
829	3	28	47	28	48	In further some time especially in developing countries, social and political intervention also limit the implementation of adaptation measures. (Kazama, So, Tohoku University)
830	3	28	49	0	0	Case of water- Brazil has several thousands of initiatives to help poor communities to adapt to climate change, while providing means for dealing with floods, droughts, heat waves, garbage reuse/recycling. They are being implemented by cooperatives, small towns, neighborhood associations; they use traditional knowledge. The main supporting organization is Fundacao Banco do Brasil published the book "Water and Climate Change". Launched during the UN's Rio+20 conference, the book shows 34 examples of how communities face and try to adapt to climate change and water; cisterns, water pits, tree plantation, agro intercropping for cattle and vegetables production, collection and reuse of city solid wastes, composting, small dams for saving water for cattle and gardening. (book by Milton N Silva et al, published by Centro de Documentacao Eloy Ferreira da Silva and Fundacao Banco do Brasil, Belo Horizonte, 2012). Copy was sent via email. (Nogueira da Silva, Milton, Climate Change Forum of Minas Gerais, Brazil)
831	3	28	51	0	0	Section 3.6.5. This section should cross-reference chapter 17 and ensure coordinated assessment. (Mach, Katharine, IPCC WGII TSU)
832	3	29	4	29	5	At the local, national, and river basin... do exist in developing countries. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
833	3	29	5	29	6	The timeframe for this estimate should be specified. (Mach, Katharine, IPCC WGII TSU)
834	3	29	10	29	13	Clarify if this refers to adaptation costs in sub-Saharan Africa specifically, or global costs. (AUSTRALIA)

#	Ch	From Page	From Line	To Page	To Line	Comment
835	3	29	10	29	13	It would be helpful to specify if this also pertains to sub-Saharan Africa. (Mach, Katharine, IPCC WGII TSU)
836	3	29	10	29	13	Are these costs global or specific to Sub-Saharan Africa? Are they the source of the 50-70% mentioned in the executive summary? Please clarify. (Mastrandrea, Michael, IPCC WGII TSU)
837	3	29	15	29	15	Either the word "needed" may be deleted or sentence need to be rephrased (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
838	3	29	17	29	22	Where "up to 2030" is mentioned, it could be helpful to clarify the full relevant timeframe--2010-2030? (Mach, Katharine, IPCC WGII TSU)
839	3	29	28	0	0	Section 3.6.6. This section does not fully focus on case studies. It could be best to integrate this material into earlier subsections. (Mach, Katharine, IPCC WGII TSU)
840	3	29	38	29	48	the incorporation of climate change into water resources... climate change over the next few decades. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
841	3	30	4	30	9	In the fourth group, note that the paper published by Howard et al 2010 noted above (which also appears in greater length on the WHO website) address issues around adaptation in the wider water and sanitation service delivery sector (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
842	3	30	7	30	16	Please qualify this statement with examples "institutional structures have the potential... is a significant barrier." (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
843	3	30	11	30	21	This paragraph should also refer to the work done by the World Bank on climate change and utilities (Danilenko et al 2010) (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
844	3	30	24	30	24	Some text is needed to explicitly highlight that freshwater systems should not be considered in isolation. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
845	3	30	24	30	24	Some text is needed to explicitly highlight that freshwater systems should not be considered in isolation. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
846	3	30	24	30	24	linkages or links? (Cassardo, Claudio, University of Torino)
847	3	30	26	0	0	This section is too short and does not justify a section and a title. (Laignel, Benoit, University of Rouen)
848	3	30	26	30	26	A similar section on "Impacts of adaptation in freshwater systems on other sectors" is missing but necessary - e.g. irrigation requirements may cause conflicts with say, recreational / tourism activities. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
849	3	30	26	30	26	A similar section on "Impacts of adaptation in freshwater systems on other sectors" is missing but necessary - e.g. irrigation requirements may cause conflicts with say, recreational / tourism activities. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
850	3	30	28	30	35	I suggest the revision of this para should be as follows: Adaptation in other sector such as agriculture, forestry and industry may have impacts on the freshwater system and have to be considered while planning adaptation measures in the water sector. For example, improving agriculture land management practices and sustainable management of forests can also lead to reduction in erosion and sedimentation of river channels as well as improvement of water quality. Some adaptation measures in other sectors may cause negative impacts in the water sector, e.g. increased irrigation upstream may limit water availability downstream (World Bank, 2007). Furthermore, a project designed for other purposes may also deliver increased climate change resilience as a co-benefit, even without a specifically identified adaptation component (World Bank, 2007, Falloon and Betts, 2010). (wang, chunfeng, State Forestry Administration, China)

#	Ch	From Page	From Line	To Page	To Line	Comment
851	3	30	28	30	35	Reference should be made to the adaptation of changes of irrigation methods and crop cultivation. They could result in significant smaller water demands without changes in crop production. (Athanasios Loukas, Civil Engineering Department, University of Thessaly, Greece) (GREECE)
852	3	30	28	30	35	More citations should be provided for these statements, if possible. (Mach, Katharine, IPCC WGII TSU)
853	3	30	46	31	2	Concerning the impacts on runoff by afforestation cannot be simply considered to result in large-scale and long-term reduction of average runoff. The impacts of afforestation on runoff have close relationship with the climate (mainly precipitation), soil type, site condition, site preparation, tree species planted etc. immediately after afforestation, runoff can be reduced, but runoff underground can be increased, such as the study taken by WANG Jin-Xin-?Huang-Bao-Long-?Luo-Wei-Xiang. Influence of Land Preparation for Afforestation on Runoff Producing and Transport from Slopes with Young Planted Trees System[J] , 2004,V2(3): 36-40?. This para cites the literature of (Trabucco et al, 2008), which comes to conclusions just based on several case studies. The conclusions in the literature are suitable for dry region, but not suitable for wet region. Therefore, revision suggested is as follows?\nAfforestation of areas suitable according to the Clean Development Mechanism-Afforestation /reforestation provision of the Kyoto Protocol?7.5million Km2?would lead to high and large-scale decrease of long-term average runoff in dry region (Trabucco et al, 2008). (wang, chunfeng, State Forestry Administration, China)
854	3	30	52	30	52	Replace "societ al" by societal (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
855	3	30	53	30	53	For the presumably somewhat general readership of this document, it would be wise to provide some kind of working definition here for the term "true cost," which is used a little vaguely here. (Fleming, Sean, Meteorological Service of Canada)
856	3	30	54	30	54	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
857	3	31	3	31	3	Remove the word "dealing" (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
858	3	31	4	31	5	This sentence implies that all hydropower has negative impacts on a freshwater system, but this is too broad a statement to be included. It should be changed to read that hydropower CAN have negative impacts. (Lane, Tracy, International Hydropower Association (IHA))
859	3	31	14	31	14	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
860	3	31	15	0	0	Change to "an already high..." (Ambulkar, Archis, Brinjac Engineering Inc.)
861	3	31	15	31	15	change "a already" in "an already" (Cassardo, Claudio, University of Torino)
862	3	31	19	31	20	Again, the text implies that all impacts are negative, and that all hydropower brings negative impacts This should be changed to read that hydropower "CAN negatively affect freshwater ecosystems" (unless the supporting research has tested all hydropower installations worldwide). (Lane, Tracy, International Hydropower Association (IHA))
863	3	31	19	31	25	This section appears to assume all hydropower requires storage and does not take into account the more limited impact of the run of the river projects and therefore over-states the adverse impact. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
864	3	31	22	31	25	This statement needs to explain why or how the global warming potential can be higher than coal. (AUSTRALIA)
865	3	31	22	31	25	Again, the science referenced in this section is questionable. Many of the research programmes working in the area of GHG and freshwater reservoirs wouldn't support these conclusions. The statements made here even contradict IPCC's own work conducted in the same time frame. (Lane, Tracy, International Hydropower Association (IHA))
866	3	31	27	31	27	Casual usage of "very likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
867	3	31	27	31	29	CO2 is injected into deep saline aquifer at depth below about 900 m (typically about 1000-2000 m) in CCS operation. CCS is little relationships to freshwater accessed. The description just say the impacts if CO2 leaked and achieved freshwater. The possibility will be very low. The description is partial and therefore should be deleted. (Akimoto, Keigo, Research Institute of Innovative Technology for the Earth (RITE))
868	3	31	32	31	32	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
869	3	31	38	31	47	The meaning of this paragraph is difficult to understand. The ratio of the electricity consumption for the water management relative to the total electricity consumption is naturally different among countries depending on the population, industrial structure, and etc. It might be a good idea to describe the electricity consumption for the water supply (treatment, or irrigation) and its intensity (i.e., the electricity required to one unit of the supply), from the view point of the capacity of climate change mitigation. (HAYASHI, Ayami, Research Institute of Innovative Technology for the Earth (RITE))
870	3	31	38	32	5	Section 3.7.2.2 can also pinpoint and discuss the climate change mitigation dimension of several new technologies relating to water supply enhancement, and particularly desalination, which is a highly energy intensive process. See for example the general discussion in McEnvoy and Wilder, 2012, Discourse and desalination: Potential impacts of proposed climate change adaptation interventions in the Arizona–Sonora border region, Global Environmental Change, 22, 2, pp.353-363. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
871	3	31	40	31	41	it is really necessary to specify that the year considered is the Japanese fiscal year? (Cassardo, Claudio, University of Torino)
872	3	31	41	31	47	It would be preferable to specify the relevant time frame for these statistics. (Mach, Katharine, IPCC WGII TSU)
873	3	31	46	31	46	I assume the emissions in question here are China's GHG emissions...? (Fleming, Sean, Meteorological Service of Canada)
874	3	31	50	31	50	Casual usage of "very likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
875	3	31	52	31	52	...will also benefit water quality... Yes, and also protect aquatic habitat - an important point, given that habitat loss is on par with climate change as a worldwide ecological threat (though of course the two are related, with deforestation helping to drive global climate change, and habitat loss likely occurring in turn as a result of climate change). (Fleming, Sean, Meteorological Service of Canada)
876	3	32	1	32	0	More studies are also needed from not only the science, but also the adaptation perspective, especially those in practical terms. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
877	3	32	1	32	3	For the description, "global CH4 emissions from rice fields could be decrease by 4.1 Tg/a (15%)," the time point under the evaluation should be mentioned. (HAYASHI, Ayami, Research Institute of Innovative Technology for the Earth (RITE))
878	3	32	6	0	0	This section is particularly interesting and original and summarized well the questions about the relationships between climate change on hydrology and water resources changes. (Laignel, Benoit, University of Rouen)
879	3	32	6	32	6	More studies are also needed from not only the science, but also the adaptation perspective, especially those in practical terms. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)

#	Ch	From Page	From Line	To Page	To Line	Comment
880	3	32	6	32	54	Clarify what is meant here. Do authors mean to suggest the climate science community should develop single models that integrate natural hydrology with water management activities? There are many examples of loosely coupled model systems where one component does hydrology and the other water management. Also, there is software that marries the two (e.g., Stockholm Environment Institute's WEAP). (UNITED STATES OF AMERICA)
881	3	32	6	32	54	Good start, but a few points could be made here. (i) Suggest broadening the discussion on lines 17-19 to address LULC change more generally, including anthropogenic changes, glacier recession, etc. (ii) Provide some kind of convincing backup to the assertion about the "...typical engineering criterion of a 1% probability of annual exceedance." (iii) Lines 45-51 seem to imply that increased reliance on groundwater is a potential solution, which it almost certainly isn't in most places... the language could be refined just a little. (iv) An additional knowledge gap, which has a pretty high profile within the statistical hydrology and statistical hydroclimatology communities, is that we need a better understanding of the physical sources of long-term persistence in hydroclimate datasets and its implications to assessing the water resource impacts of anthropogenic global climate change. (v) Perhaps the most pressing knowledge gap at present is how climate change will affect hydrologic extreme events - work is being done on this, but it is a particularly difficult aspect of the question. (Fleming, Sean, Meteorological Service of Canada)
882	3	32	6	32	54	There is a clear research need to understand how water and service delivery, particularly in developing countries and this should be flagged. (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND)
883	3	32	17	32	19	add after line 19: Digital models might be used for quantitative and quality simulations of water state as well as for transport of substances that pollute surface and groundwater. Current knowledge, which allow to analyse mechanisms ruling systems of ground and surface water, should still be advanced in order to allow correct implementation of policy (POLAND)
884	3	32	18	32	18	Authors should provide a citation for this statement. It links with other discussions in the chapter. (UNITED STATES OF AMERICA)
885	3	32	19	32	19	Link this sentence to box CC-VW? (Falloon, Peter, Met Office Hadley Centre)
886	3	32	21	32	25	Studies on non-monetary, indirect, social, environmental costs are missing but important. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
887	3	32	27	0	0	Riverdischarges have been projected with the 20-km mesh AGCM and their uncertainties have been quantified with the 60-km mesh AGCM. Therefore, this mismatch is not continuing but disappearing. The regional future climate changes in AR5 WG I have been projected with the 60-km mesh AGCM. Please see Chapter 21 in the WG I. References are listed below:\n* Kwak, Y., K. Takeuchi, K. Fukami, and J. Magome 2012: A new approach to flood risk assessment in Asia-Pacific region based on MRI-AGCM outputs. Hydrological Research Letters 6, 70–75.doi: 10.3178/HR.L.6.70\n* Kure, S., and T. Tebakari 2012: Hydrological impact of regional climate change in the Chao Phraya RiverBasin, Thailand. Hydrological Research Letters 6, 53–58. DOI: 10.3178/HR.L.6.53\n* T. Nakaegawa, C. Wachana, and KAKUSHIN Team-3 Modeling Group. First impact assessment of hydrological cycle in the Tana River basin, Kenya, under a changing climate in the late 21st Century. Hydrological Research Letters., Vol. 6, pp.29-34, (2012) .\n(continued) (Nakaegawa, Toshiyuki, Meteorological Research Institute)

#	Ch	From Page	From Line	To Page	To Line	Comment
888	3	32	27	0	0	* Champathong, A. D. Komori, M. Kiguchi, T. Sukkhapunnapan, T. Nakaegawa, and T. Oki. 2013: Future projection of mean river discharge climatology for the Chao Phraya River basin. Hydrological Research Letters. Vol.7, in press.\n* J. Fábrega, T. Nakaegawa, R. Pinzón, K. Nakayama, O. Arakawa, SOUSEI Theme-C modeling group. 2013: Hydroclimate projections for Panama in the late 21st Century. Hydrological Research Letters. Vo.7., in press.\n* Akio Kitoh, Akiyo Yatagai and Pinhas Alpert: "First super-high-resolution model projection that the ancient "Fertile Crescent" will disappear in this century", Hydrological Research Letters, Vol. 2, pp.1-4, (2008) .\n* Nakaegawa, T., A. Kitoh, M. Hosaka. 2013: Discharge of major global rivers in the late 21st century climate projected with the high horizontal resolution MRI-AGCMs -overview-. Hydrological Processes. 27. DOI: 10.1002/hyp.9831\n* Kitoh, A., S. Kusunoki, and T. Nakaegawa, 2011: Climate change projections over South America in the late 21st century with the 20 and 60 km mesh Meteorological Research Institute atmospheric general circulation model (MRI-AGCM). Journal of Geophysical Research, 116, D06105. (Nakaegawa, Toshiyuki, Meteorological Research Institute)
889	3	32	27	32	27	the use of the term "scale" is unclear. does it mean resolution? anyhow 200 for climate and 20 for catchment seem bizarre (ITALY)
890	3	32	27	32	28	After the end of this sentence includes: Even though recently Fabrega et al., 2013 and Nakaegawa et al., 2013 have employed a methodology to measure consistency between 20 km high resolution model and various projections at 60 km scale ensemble simulation. The corresponding references are: T. Nakaegawa, A. Kitoh, M. Hosaka. 2013: Discharge of major global rivers in the late 21st century climate projected with the high horizontal resolution MRI-AGCMs-overview. Hydrological Processes. 27 DOI:10.1002/hyp. 9831. ----- J. Fábrega, T. Nakaegawa, R. Pinzón, K. Nakayama, O. Arakawa, SOUSEI Theme-C modeling group. 2013: Hydroclimate projections for Panama in the late 21st Century. Hydrological Research Letters Vol. 7, in press (Fábrega, José, Universidad Tecnológica de Panamá)
891	3	32	27	32	36	The increasing interest in using integrated hydrologic (and climate) models for climate research may be a relevant point to consider adding here. (UNITED STATES OF AMERICA)
892	3	32	31	32	33	Clarify the sentence starting with "Climate extremes". Do authors mean extremes expressed by climate model simulations or in observations? What types of extremes? (UNITED STATES OF AMERICA)
893	3	32	38	0	43	The paragraph is unclear and text needs to be checked (ITALY)
894	3	33	0	33	0	General comment - FAQ 3.2:\nWhere is the discussion on drought?!?! (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
895	3	33	0	34	0	General comment - FAQ : \nA question such as "What needs to be taken into consideration when planning for freshwater resources under future climate?" is needed. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
896	3	33	1	33	0	Where is the discussion on drought?!?! (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
897	3	33	1	34	0	A question such as "What needs to be taken into consideration when planning for freshwater resources under future climates?" is needed. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
898	3	33	2	34	16	Section Frequently Asked Questions: There should be a FAQ on drought, particularly since there is one on floods. (UNITED STATES OF AMERICA)
899	3	33	4	0	10	The answer to this FAQ is quite technical. Suggest increasing policy relevance and explaining more technical terms (e.g., evapotranspiration) a little more where possible. It would also be helpful if the sources of uncertainty could be explained. (CANADA)

#	Ch	From Page	From Line	To Page	To Line	Comment
900	3	33	6	33	6	"Increase in land evapotranspiration may become limited by the water availability" see see Fig.10 in kumar et al. 2013(d).\nReference:\nKumar S., P. A. Dirmeyer, V. Merwade, T. DelSole, J. M. Adams, and D. Niyogi, 2013(d): Land Use/Cover Change Impacts in CMIP5 Climate Simulations –A New Methodology and 21st Century Challenges. Journal of Geophysical Research (Atmospheres), doi:10.1002/jgrd.50463, in press. (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
901	3	33	6	33	6	Casual usage of "very likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
902	3	33	7	33	7	Specify the meaning of the acronym RBMP (River Basin Management Plan?) (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
903	3	33	8	33	8	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
904	3	33	9	0	0	Change to "to decreases" from "ot decreases" (Ambulkar, Archis, Brinjac Engineering Inc.)
905	3	33	9	33	9	ot => to : Typo (REPUBLIC OF KOREA)
906	3	33	9	33	9	change "ot" in "to" (Cassardo, Claudio, University of Torino)
907	3	33	9	33	9	to (ITALY)
908	3	33	12	0	0	FAQ 3.2: The question should address extreme events and not only floods, as drought and its impacts on water resources are of similar, critical importance. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
909	3	33	12	33	27	FAQ3.2 Major consistency along the chapter is necessary (Llasat, Maria-Carmen, University of Barcelona)
910	3	33	17	0	0	Suggest changing to "limited AREAL extent" (CANADA)
911	3	33	18	0	19	Suggest adding also that there will be less precipitation stored in snowpack and hence less snow-melt driven flooding during snow melt in spring; however, there may be more winter flooding due to winter rain events or rain on snow events. (CANADA)
912	3	33	18	33	19	The magnitude of spring snowmelt floods... Fine, but it should be noted here that whether a given snowpack produces a flood may depend less on the size of the snowpack and more on the intensity and duration of springtime hot spells - tying back to questions of how climate change may affect meteorological extreme events. (Fleming, Sean, Meteorological Service of Canada)
913	3	33	18	38	18	Casual usage of "likely" should be avoided, as it is a reserved likelihood term. (Mach, Katharine, IPCC WGII TSU)
914	3	33	19	19	22	The author may wish to note that a couple of studies have suggested that flood hazards may also increase along the Pacific coast of Canada, though admittedly both these studies are not very recent (Whitfield et al., 2003, Canadian Water Resources Journal, 28(4), 633-656; Weston et al., 2003, Canadian Water Resources Journal, 28(4), 657-672). (Fleming, Sean, Meteorological Service of Canada)
915	3	33	20	33	20	East Africa, Central and Western Africa: why you do not say simply Africa? Also page 19 line 39 (Cassardo, Claudio, University of Torino)
916	3	33	29	33	41	FAQ 3.3: Suggest authors replace "It depends" with "There are complex linkages and interactions that must be considered together." Add to the sentence which begins "Impacts on freshwater stressors" the term "population growth". (UNITED STATES OF AMERICA)
917	3	33	35	33	35	Yes, deforestation, and probably also urbanization (conversion from either natural or agricultural uses) (Fleming, Sean, Meteorological Service of Canada)
918	3	33	40	33	41	Should the dependence of this outcome on the level of climate change be clarified? (Mach, Katharine, IPCC WGII TSU)
919	3	33	43	33	43	The wording of this question should be revised to ensure that the formulation is not prescriptive. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
920	3	33	43	33	52	Proper water management incorporates natural resource management, social measures and infrastructure development, which should be done comprehensively. Within the national irrigation strategy are integrated multiple tools in order to increase food security and adapt to climate change impacts without neglecting other sectors. Among the tools used are the promotion of management to improve organizational capacity of water users to manage water resources, especially in times of scarcity; also develop and conduct headworks; has been invested in the development of telemetry projects and infiltration of groundwater, among others in order to have a varied range adaptive measures. (CHILE)
921	3	33	44	0	45	This sentence could be read as prescriptive. Suggest reframing in terms of current knowledge of water management practices. (CANADA)
922	3	33	47	33	47	In addition to "maintaining vegetation cover," may also wish to explicitly and specifically include "maintaining or restoring riparian vegetation," which is particularly important from freshwater ecology and fisheries perspectives. (Fleming, Sean, Meteorological Service of Canada)
923	3	33	49	33	52	In discussing how water management should be adapted in the future, large scale infrastructure such as dams and irrigation systems are noted to be maladaptive measures. This statement is not supported by any text nor references in the main text of the chapter and seems somewhat suggestive. We propose to elaborate on this in section 3.7.2.2. This discussion may then also indicate some of the reasons that such infrastructure fails to deliver including suboptimal operation and/or poor maintainance (see e.g. Labadie, 2004). \n\nLabadie, J. (2004). "Optimal Operation of Multireservoir Systems: State-of-the-Art Review." J. Water Resour. Plann. Manage., 130(2), 93–111. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Policy Unit)
924	3	34	1	0	9	This FAQ seems like it is intended to also provide some perspective on whether there are opportunities or benefits associated with climate change and water resources, but never actually goes in that direction. Is there more of a story to tell here? (CANADA)
925	3	34	3	34	3	same places, I suggest to add "and times" (Cassardo, Claudio, University of Torino)
926	3	34	4	0	0	FAQ 3-1 Authors may wish to provide some details like time splices of when, where and by how much. At present the answer is too general and doesn't really provide any specific take away points. (Chatterjee, Monalisa, IPCC WGII TSU)
927	3	34	4	34	4	but in ... detectable: the 'consecutio temporum' is strange: I suggest to change in "but in some regions they will become statistically detectable some decades later" (Cassardo, Claudio, University of Torino)
928	3	34	5	34	7	Glacial meltwater contributions are already declining in many parts of the world. Some key references are as follows: (i) Baraer M, Mark BG, McKenzie JM, Condom T, Bury J, Huh K-I, Portocarrero C, Gómez J, Rathay S. (2012), Glacier recession and water resources in Peru's Cordillera Blanca, Journal of Glaciology, 58:134-150; (ii) Stahl, K., Moore, R.D., 2006. Influence of watershed glacial coverage on summer streamflow in British Columbia, Canada. Water Resources Research, 42, doi:10.1029/2006WR005022; (iii) Stahl K, Moore RD, Shea JM, Hutchinson DG, Cannon A. 2008. Coupled modelling of glacier and streamflow response to future climate scenarios. Water Resources Research, 44, doi:10.1029/2007/WR005956; (iv) Moore, R.D., Fleming, S.W., Menounos, B., Wheate, R., Fountain, A., Stahl, K., Holm, K., Jakob, M., 2009. Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality. Hydrologic Processes 23: 42–61; (v) Jost, G, and others (2012), Hydrology and Earth System Science, 16, 849–860. (Fleming, Sean, Meteorological Service of Canada)
929	3	34	11	0	16	This FAQ does not link sufficient to the chapter topic (water resources). Suggest that the concepts of "portfolio" and "no regrets adaptation" need to be better linked to the water resources discussion. (CANADA)

#	Ch	From Page	From Line	To Page	To Line	Comment
930	3	34	12	0	0	FAQ 3-2 Chapter FAQs should highlight findings that come out of the specific chapter assessment and not from other assessments. The flow of the answer would appeal more to a wider audience if it begins with what is emerging as consistent findings (e.g. flood hazards) and then move into challenges with uncertainty. The flood hazard and flood damage tension is good to highlight here, but the importance of increased exposure and vulnerability is subtly given, it may be better to make it more clear. Authors may wish to consider these changes in their revisions. (Chatterjee, Monalisa, IPCC WGII TSU)
931	3	34	18	34	18	Specify the meaning of the acronym EACC (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
932	3	34	29	0	0	FAQ 3-3 The FAQ is very useful. The language could be a little more direct and forceful. It may be useful to summarize the factors that will play a role in the first sentence with 'it depends'. (Chatterjee, Monalisa, IPCC WGII TSU)
933	3	34	30	34	41	The paragraph seems to be inconsistent with what stated above, in particular for what concerns impacts in 2050s (ITALY)
934	3	34	43	0	0	FAQ 3-4 The answer reads more like a list. Perhaps another sentence on how managing resources, social measures and infrastructure development can interface positively will be useful. The reference to maladaptive actions is useful but a little abrupt. Perhaps a connecting sentence will be useful. (Chatterjee, Monalisa, IPCC WGII TSU)
935	3	35	1	0	0	FAQ 3-5 The message is very general, unless the chapter has specific findings on this and can provide details, perhaps the question can be dropped. Alternatively, authors may wish to change the FAQ and make 'meltwater dividend' the catch phrase and exclusive focus on that if there is strong literature on it. (Chatterjee, Monalisa, IPCC WGII TSU)
936	3	35	11	0	0	FAQ 3-6 Although the content of this FAQ will be useful to the wider audience, the subject doesn't seem to fit with the scope of chapter 3. Authors can perhaps check and suggest to other chapters where it would fit more naturally. (Chatterjee, Monalisa, IPCC WGII TSU)
937	3	35	21	35	27	Kudos for addressing the topic here. However, I think there are some significant issues with the passage as written, at least with respect to glacial rivers. I suggest the author re-reads in detail the Jacobsen et al. paper already cited here, and additionally consults the following papers for a better picture of the subject: (i) Milner AM and others (2009), Hydroecological response of river systems to shrinking glaciers. Hydrological Processes, 23: 62-77; (ii) Dorava JM, and Milner AM (2000), Role of lake regulation on glacier-fed rivers in enhancing salmon productivity: the Cook Inlet watershed, south central Alaska, USA. Hydrological Processes, 14: 3149-3159; (iii) Fleming SW (2005), Comparative analysis of glacial and nival streamflow regimes with implications for lotic habitat quantity and fish species richness. River Research and Applications, 21:363-379; (iv) Ward JV (1994), Ecology of alpine streams. Freshwater Biology, 32:277-294; (v) Moore RD and others (2009), Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality. Hydrological Processes, 23:42-61. (Fleming, Sean, Meteorological Service of Canada)
938	3	36	35	40	18	A relevant study is: Davie, J. C. S., et al. (2013).: Comparing projections of future changes in runoff and water resources from hydrological and ecosystem models in ISI-MIP, Earth Syst. Dynam. Discuss., 4, 279-315, doi:10.5194/esdd-4-279-2013, 2013. (Dankers, Rutger, Met Office Hadley Centre)
939	3	36	43	36	43	iWUE requires a definition of what is meant by intrinsic (ITALY)
940	3	37	34	37	34	After Cao et al 2009, insert "or a decrease in runoff, depending on the strength of the competing factors of enhanced plant growth and reduced stomatal conductance (Davie et al. 2013)". This study from the ISI-Mip project found that in models including CO2 effects, elevated CO2 could act to either increase or decrease runoff, which is the major finding relevant here. The sentence will likely need reworking as it is already long. The Davie et al. reference is already in the chapter reference list. (Falloon, Peter, Met Office Hadley Centre)

#	Ch	From Page	From Line	To Page	To Line	Comment
941	3	38	0	0	0	Figure VW-1 „Top bottom, with without“ seem interchanged to me (Blazkova, Sarka D., T.G. Masaryk Water Research Institute)
942	3	38	7	38	7	coverage, as (ITALY)
943	3	38	9	0	9	17% in (ITALY)
944	3	39	15	22	18	There are several paragraphs that are authentic miscellaneous of ideas some of them without any interconnection - e.g., pg. 39, lines 15 to 22 "hydropower generation leads to fragmentation of river channels and to alteration of river flow regimes that negatively affect freshwater ecosystems, in particular biodiversity and abundance of riverine organisms (Döll, 2009; Poff and Zimmerman, 2010). In particular, hydropower operation often leads to fast sub-daily discharge changes that are detrimental to the downstream river ecosystem (Bruno et al., 2009; Zimmerman et al., 2010). If, in tropical regions, the ratio of hydropower generation to surface area of the related reservoir is less the 1 MW/km2, the global warming potential (CO2-eq. emissions from the reservoir per MWh produced) can be higher than in the case of coal use for energy production (Gunkel, 2009). Densification of urban areas to reduce traffic emissions may conflict with provisioning additional open space for inundation in case of floods (Hamin and Gurrán, 2009)". (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
945	3	40	18	40	18	Remove the word "so" (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
946	3	40	18	40	19	Review the last paragraph (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
947	3	40	30	40	31	The paragraph "Climatic extremes of concern in water management generally recur more frequently than the typical engineering criterion of a 1% probability of annual exceedance" as nothing to do with the content under discussion. (Portela, Maria Manuela, Instituto Superior Tecnico (IST))
948	3	41	2	41	2	Really? It would be interesting to cite here just which countries spend nearly half their total energy use just on pumping groundwater...? (Fleming, Sean, Meteorological Service of Canada)
949	3	44	15	44	17	Just a comment that the debate “spawned by the Stern (2007) Review” which is mainly a Western debate was spawned only because Stern proposes a low discount rate is as old as Ramsey who invented the intertemporal optimization approach and in the end argued against the use of discount rates in this approach. (Montes, Manuel F., South Centre)
950	3	47	13	47	16	The example that China’s high growth rate could justify a high discount rate as much as 15 per cent in the example is an application of a microeconomic idea (discounting) applicable to projects to a macroeconomic observation (China’s high national growth rate). Economists often hide the analytical gulf between microeconomic and macroeconomics analysis for the benefit (or to the detriment) of non-specialists. If China’s national growth rate could suddenly collapse because of the unsustainable financial growth, then an argument can be made for a much lower discount rate. (Montes, Manuel F., South Centre)

#	Ch	From Page	From Line	To Page	To Line	Comment
951	3	51	37	51	37	In accordance with comment above (ch. 3, p. 15, l. 4) the following reference should be added: Jóhannesson, T., G. Aðalgeirsdóttir, A. Ahlstrøm, L. M. Andreassen, S. Beldring, H. Björnsson, P. Crochet, B. Einarsson, H. Elvehøy, S. Guðmundsson, R. Hock, H. Machguth, K. Melvold, F. Pálsson, V. Radi?, O. Sigurðsson and Th. Thorsteinsson. 2012. Hydropower, snow and ice. In: Thorsteinsson, Th., and H. Björnsson, eds. Climate Change and Energy Systems. Impacts, Risks and Adaptation in the Nordic and Baltic Countries. Nordic Council of Ministers, TemaNord 2011:502, 91–111. (ICELAND)
952	3	64	0	0	0	Please revise ref.7 in the table 3-1. In the seventh row of table 3-1, there is "Disappearance of Chacaltaya Glacier. Bolivia (2009), but ref.7 is from Rosenzweig et al 2007. (Chunzhen, Liu, Ministry of Water Resources)
953	3	64	0	0	0	Table 3.1, Reference # 7: "Ascent of freezing isotherms at 50 meters per decade". It would be more appropriate to mention the period in which this change has been observed (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
954	3	64	0	0	0	Table 3.1, Reference # 12: It is suggested that either "Increase temperature and precipitation" is enough as attribute or 1 or 2 examples of confounding factors may please be added by saying such as (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
955	3	64	0	0	0	Table 3-1 Caption: "Selected examples, mainly from Section 3.2, of the observation, detection and attribution of impacts of climate on freshwater resources." Delete 'change' since the following sentence points out "Observed hydrological changes are attributed here to their climatic drivers, which are not all known to be anthropogenic; In the cast of #15, the change in hurricane frequency have been shown to be in response to the Atlantic Multidecadal Oscillations. The statement in AR5 WG1 is "Consistent with SREX, there is low confidence in attribution of changes in tropical cyclone activity to human influence due to insufficient observational evidence and low level of agreement between studies." (UNITED STATES OF AMERICA)
956	3	64	0	0	0	Table 3-1: The figure complement to the table is hard to read and not useful. It would be better to (1) eliminate the figure, and (2) switch the table to landscape with columns added to indicate "degree of confidence in detection" and "degree of confidence in detection and attribution". (UNITED STATES OF AMERICA)
957	3	64	0	0	0	Table 3-1: Decreases in groundwater recharge are related to precipitation and air temperature, but cannot be attributed to (anthropogenic or other) climate change with any confidence based on the studies cited. Refs 10 (Aguilera and Murillo, 2009) and 11 (Jeelani, 2008) show historical trends and use conceptual/empirical models to fit these trends. They did not incorporate CO2 effects on transpiration, and the hydrology models were very simplistic. Thus the "Degree of Confidence in Attribution" should be "Very Low." (UNITED STATES OF AMERICA)

#	Ch	From Page	From Line	To Page	To Line	Comment
958	3	64	0	0	0	Table 3-1: The figure embedded in the table is not only hard to read but somewhat misleading since it shows only "Selected examples" and none of the selected examples are for the vast major of possible but not selected examples that have either a 'very low' or 'low' 'degree of confidence in detection'. Suggest either deleting the embedded figure or shade the left 2/5s of the figure ('very low' or 'low') a different color to remind the reader that the vast majority of possible examples are not plotted. (UNITED STATES OF AMERICA)
959	3	64	0	0	0	Table 3.1: Includes material on D&A - please check and ensure consistency with WGI Ch10 and WGII Ch18 of AR5. Table has been expanded to now also include graphic on D&A degree of confidence; What is the basis for this figure, expert elicitation? Please clarify. (Plattner, Gian-Kasper, IPCC WGI TSU)
960	3	64	0	0	0	Table 3-1: It would be easier for the reader to follow all information in a single table instead of having some of the information as a chart and some in a table format. The table could include new columns: 1) degree of confidence in detection; 2) Degree of confidence in DnA; and possibly 3) Location; and 4) Year observed which can be separated from the Observed Change column for better organization of the table. (Estrada, Yuka, IPCC WGII TSU)
961	3	64	0	0	0	Table 3-1. The combination of figure and table is effective. Several further adjustments to the table could be considered. 1st, it would be helpful to add an initial column to the table that specifies which of the 5 symbol categories the example falls under. 2nd, within the attribution column in the table, a brief annotation could be used within the column for clarity and ease of reading, specifying the type of attribution, for example: "[ACC]" or "[end to end]." 3rd, given that only one reference is relevant to each line of the table, the references could simply be provided within the final column. Finally, a few specific points for the examples: it would be best to specify the timeframe for the reduced runoff for the Yellow River. Then, could it be clarified what is meant by "fraction of risk of flooding"? For examples where only states are given, it could be clearest to also specify the relevant country. (Mach, Katharine, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
962	3	64	0	64	0	Data series used in the references “Piao et al (2010)” is short, and attribution of runoff change in this reference was also cited from another old reference. Therefore, we add three more references to Table 3-1 to renew conclusions for China, which are listed as follows: “Wang and Yan et al (2013), Wang and Zhang, et al (2012), Bao et al (2012)”. Some changes in Table 3-1 are : (1) to change “Reduced runoff (Yellow River, China)” in Table 3-1 to “Reduced runoff (Kuye River in the Yellow River basin, Hai River, China)”; (2) to change “increased temperature, only 35% of reduction attributable to human withdrawals” to “mostly contributable to human activities including land use change, human consumption, etc, such as the Yellow River and Hai River, climate change contributes to 25%~45% of runoff reduction”\nReferences\n(1) Wangm G. Q. Yan, X. L. Yan. Zhang, J.Y. et al., 2013: Detecting evolution trends in the recorded runoffs from the major rivers in China from 1950~2010. Journal of Water and Climate Change. 2013. (accepted,will be published in 2013)\n(2) Wang, G. Q. Zhang, J.Y.Pagano, T. C. et al. 2013: Identifying contributions of climate change and human activity to changes in runoff using epoch detection and hydrologic simulation. Journal of Hydrologic Engineering. 2012. doi:10.1061/(ASCE)HE.1943-5584.0000559 (accepted,will be published in 2013)\n(3) Bao, Z.X. Zhang, J.Y. et al., 2013: Attribution for decreasing streamflow of the Haihe River basin, northern China: Climate variability or human activities?”. Journal of Hydrology. http://dx.doi.org/10.1016/j.jhydrol.2012.06.054 \n (Wang, Guoqing, Nanjing Hydraulic Research Institute)
963	3	65	0	0	0	Table 3-2. An additional reference may be included in this table:\n- Type of hydrological change or impact: Spatio-temporal drought event characteristics\n- Description of indicator: Mean duration, affected area and total magnitude of drought events over France\n- Hydrological change or impact in different emissions scenarios or different degrees of global warming: reduced increase in all severity characteristics under the B1 scenario compared to A2 and A1B\n- Reference: Vidal, J.-P., Martin, E., Kitova, N., Najac, J., and Soubeyroux, J.-M. (2012) Evolution of spatio-temporal drought characteristics: validation, projections and effect of adaptation scenarios. Hydrology and Earth System Sciences, 16(8), 2935-2955. doi: 10.5194/hess-16-2935-2012 (Vidal, Jean-Philippe, Irstea)
964	3	65	0	0	0	Please add projected decade in the 1st, 3th, 4th, 10th and 15th row in the second column of table 3-2 and add description of indicator in the 8th row. (Chunzhen, Liu, Ministry of Water Resources)
965	3	65	0	0	0	Table 3.2, Reference Schewe at al.: Under description of indicators requires to be rephrased for the sake of clarity (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))
966	3	65	2	65	2	second row, 1st column: change "Decrease" in "Decrease" (Cassardo, Claudio, University of Torino)
967	3	66	0	0	0	GCM20 should be MRI-AGCM3.2S. Please confirm it 3.1 or 3.2 since Fukubayashi has not yet been published. (Nakaegawa, Toshiyuki, Meteorological Research Institute)
968	3	66	0	0	0	Table 3.2, Reference Van Vliet at al.: In column 2, delete word "with" as it is used twice (ALI, GHAZANFAR, GLOBAL CHANGE IMPACT STUDIES CENTRE (GCISC))

#	Ch	From Page	From Line	To Page	To Line	Comment
969	3	66	0	0	0	Table 3-3. The qualifying categories used for this table (CC, M and M+A) would benefit from clarification. It is not fully clear what is meant by particularly relevant to climate change. Additionally, it is not clear how assisting mitigation and adaptation is different from also assisting mitigation. For all examples within the table, footnotes for the relevant citations given at the end of the table should be specified throughout. (Mach, Katharine, IPCC WGII TSU)
970	3	66	0	66	0	Table 3-3 - This table seems incomplete. Some cells are empty. If these cells are supposed to be empty, it may be better to put NA in these boxes. (AUSTRALIA)
971	3	66	0	66	0	Table 3-2: In the third column of last row, GCM20 should be either MRI-AGCM3.1S or MRI-AGCM3.2S. Please confirm it according to Fukubayashi et al. (2013).\n (JAPAN)
972	3	66	0	67	0	General comment - Table 3-3:\nThis table is very important for decision makers and needs reviewing, paying particular attention to presentation and communication issues, duplicates, clarity etc. \nE.g. under "Reduce impact of natural disasters", " Develop contingency plans" and "Actively seek and secure water from a diveristy of sources..." seem to be the same item.\nBesides contingency plans, disaster and emergency response and recovery is missing (e.g. water restrictions, emergency funds) (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
973	3	66	1	67	0	Table 3-3 needs substantial revision and lacks clarity due to overlaps and misinterpretation-representation of different concepts. There are repetitions (e.g. In 16-17 on the need to change cropping patterns, In. 19 and In 15 on wastewater reuse). Furthermore, measures aimed at water demand management and at more efficient water use are not only linked to a reduction of the impact of natural disasters, but also form an integral part of Integrated Water Resources Management. They also form part of "soft approaches". It would be better if the table was re-designed to towards a sectoral approach (agriculture, industry, municipal services), including infrastucture, natural disasters and institutional measures (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
974	3	66	1	67	0	This table is very important for decision makers and needs reviewing, paying particular attention to presentation and communication issues, duplicates, clarity for non-technical personnel etc. \nE.g. under "Reduce impact of natural disasters", " Develop contingency plans" and "Actively seek and secure water from a diveristy of sources..." seem to be the same item.\nBesides contingency plans, disaster and emergency response and recovery is missing (e.g. water restrictions, emergency funds). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
975	3	67	13	67	13	Is the Garnaut reference a peer-reviewed one? (Montes, Manuel F., South Centre)
976	3	68	0	0	0	The Fig.3.1 is too complex, confused and unclearly. It is better to categorize and combine some relevant elements into common terms, such as water management and non-climatic driver into "Governance" etc. The Fig.1 of SPM is a good example. I'd like to suggest revise Fig.3.1 per Fig. 1. (Chunzhen, Liu, Ministry of Water Resources)

#	Ch	From Page	From Line	To Page	To Line	Comment
977	3	68	0	0	0	Fig. 3-1: Looking at that figure I had the strong feeling that I need to consult my optician because I couldn't read most of the contents of the boxes without difficulties.....This figure has a really poor resolution. (Wurzler, Sabine, LANUV NRW)
978	3	68	0	0	0	Figure 3-1: Please provide the legend for this figure. One might get the impression that the different color arrows have some significance. Is this the case, or are they simply for contrast? If it is the latter, then a better way of distributing color should be used that is not suggestive, or simply use one color for the arrows. (Estrada, Yuka, IPCC WGII TSU)
979	3	68	0	0	0	Figure 3-1. This table would be much more effective if the number of boxes and arrows were reduced, focusing on the essence of the relationships assessed within the chapter. Right now, the reader cannot help but feel tangled in a network of tube-like arrows without seeing the overall point quickly and clearly. The text in all of the yellow square boxes would benefit from revision and clear organization. (Mach, Katharine, IPCC WGII TSU)
980	3	68	1	0	0	Figure 3-1: A legend for the colour scheme for the arrows is missing. An option could be the colour scheme to represent different components of the presented framework (e.g. driver, status, adaptation, mitigation). (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
981	3	68	1	0	0	Figure 3-1: The proposed framework is complex and one could argue that several links are missing - for example structural measures lead to changes in exposure but also to vulnerability. Also abbreviations such as SLC are not explained. I presume this is Sea Level Change - which in other parts of the reports is abbreviated to SLR; Overall Fig 3-1, in its current form, is too complicated and it should become clearer what it should explain. (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
982	3	69	0	0	0	Figure 3-2 might need to add a legend that explains or describes various conditions considered for the graphs included in the figure. (Ambulkar, Archis, Brinjac Engineering Inc.)
983	3	69	0	0	0	Could you please give more detailed assessment on the research results shown in Fig. 3.2, such as its confidence level and scientific meaning. (Chunzhen, Liu, Ministry of Water Resources)
984	3	69	0	0	0	Fig. 3-2: The labels of the ordinate are missing. (Wurzler, Sabine, LANUV NRW)
985	3	70	0	0	0	"Taiwan" in Figure 3-3 should be changed to "Taiwan, China". (CHINA)
986	3	70	0	0	0	Figure 3-3: The table describes observed impacts. Given that, the caption should read "Observations" of the impacts rather than "Observations and Projections" of the impacts. (UNITED STATES OF AMERICA)
987	3	70	0	0	0	Figure 3-3 still "under production" (ITALY)
988	3	70	0	0	0	Figure 3-3: The map shows "renewable freshwater resource" which does not seem to be referred to anywhere in the text. Would it be possible to have a map showing "water quality" so that the map will be more closely in line with the section of the chapter? (Estrada, Yuka, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
989	3	70	0	0	0	Figure 3-3. The caption indicates that projections are also provided within the graphic, but I am having a hard time figuring out which if any of the examples are projections. Also, for the examples stating "2-6 years" and "near 11 years" it would be preferable to specify the year range if possible. (Mach, Katharine, IPCC WGII TSU)
990	3	70	1	0	0	Figure 3-3: This figure presents a global view based on very local case studies. It would be important to include a statement to this in the caption to avoid interpreting conclusions found in studies to wide regions (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
991	3	71	0	0	0	Figure 3.4: This is entirely a WGI figure – rather than using the Hawkins and Sutton study here, we suggest that you refer to Ch9/11/12 of WGI AR5 to refer to the assessment of different sources of (physical science) uncertainties in projections. (Plattner, Gian-Kasper, IPCC WGI TSU)
992	3	72	0	0	0	Figure 3-5 is not clear to me. Particularly several overlapping vertical boxes. Please explore some innovative way to represent this figure. (Kumar, Sanjiv, Center for Ocean-Land-Atmosphere Studies)
993	3	72	0	0	0	Fig. 3-2. This is novel figure but I'm not sure what the take home message is other than there are more references on water quality than groundwater or extremes. More description/discussion of this figure in the text would make it more meaningful. (Macinnis-Ng, Cate, University of Auckland)
994	3	72	1	0	0	Figure 3-5: Grey boxes difficult to distinguish. Consider different colour schemes, as in the original paper (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
995	3	73	0	0	0	Figure 3.6: The legend is missing from this figure. (UNITED STATES OF AMERICA)
996	3	73	0	0	0	Figure 3-6: A clear explanation of the figure in needed. One could assume that changes under the HadCM3 model 4C increases are shown in the red line but it is unclear why the HadCM3 model 2C increases are outside of the range. (UNITED STATES OF AMERICA)
997	3	73	0	0	0	Figure 3-6. It would be helpful to specify what range is shown--5-95%? Then, it would be helpful to specify the colors corresponding to 2 and 4°C. (Mach, Katharine, IPCC WGII TSU)
998	3	73	0	73	0	A legend seems to be missing/necessary. (Yu, Rita, Climatic Research Unit & Tyndall Centre for Climate Change Research, University of East Anglia)
999	3	73	1	0	0	Figure 3-6: Include in the caption a colour legend for the two lines (corresponding to the 2oC and 4oC increase) (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
1000	3	74	0	0	0	Figure 3-7 contains a world map with national borders. It is suggested to use a map without borders to avoid unnecessary disputes. (CHINA)
1001	3	74	0	79	0	Figures 3-7, 3-8, VW-1: Robinson projection is the recommended projection for global maps. Please ensure this projection is used wherever possible to have a consistent presentation across the volume. (Estrada, Yuka, IPCC WGII TSU)

#	Ch	From Page	From Line	To Page	To Line	Comment
1002	3	76	0	0	0	Fig. 3-7. What do the different colours (arrows and other shapes) signify? (Macinnis-Ng, Cate, University of Auckland)
1003	3	76	1	77	1	figures in my opinion are too small, thus regional particulars are hardly distinguishable (Cassardo, Claudio, University of Torino)
1004	3	78	1	0	0	Figure RG-2. Could be useful to add lines indicating current glacial cover in each region (Kentarchos, Anastasios, European Union DG Research, Directorate Environment Climate Change & Environmental Risks Unit)
1005	3	78	1	78	1	which variable is plotted in the y-axis? What means "Accumulated regional species loss"? Does it mean the absolute number of species lost? (Cassardo, Claudio, University of Torino)
1006	3	79	0	0	0	Figure VW-1 contains a world map with national borders. It is suggested to use a map without borders to avoid unnecessary disputes. (CHINA)
1007	3	79	1	79	1	not clear to me the difference between top and bottom figure. Above the graph it is written: with/without CO2. But in the caption they are referenced as only CC/also other things plus CC ("additionally"). So from the captions I understand that also bottom figure contains CO2 effect? Am I wrong? Could you explain it better? (Cassardo, Claudio, University of Torino)