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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Urban water sustainability: an integrative framework for regional water management" *by* P. Gonzales and N. K. Ajami

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Under the uncertainties of climate change and rapid population growth, the risk of water scarcity in urban areas is amplified by unsustainable water resources management. Gonzales and Ajami call for a more collaborative effort to develop alternative and more sustainable water supply and demand portfolios that address the complexity of hydrologic, socio-economic, and governance dynamics of water resources management. To aid in the development of more sustainable water resources management, the authors present an integrative and practical sustainability framework to critically assess the limitations of current water resources management practices and identify

potential opportunities to improve sustainability. The framework incorporates hydrological, socio-economic, and governance factors to provide a more holistic analysis of socio-hydrological systems. As part of the framework, they introduce a novel way to determine water supply diversity by adopting the Gini-Simpson index.

I thoroughly enjoyed reading the article and am impressed with the practicality of the framework and the novelty of using the Gini-Simpson index in the field of water resources management. By testing their framework on the Hetch Hetchy regional water system in California, they successfully demonstrate how their holistic framework can critically assess the sustainability of water resources management practices and be used to identify potential opportunities to enhance sustainability at a regional level. I appreciate the authors' insight on how agencies may be hesitant on changing their water supply portfolios due to financial risk; and how they identified the need for future research on how to spread the risks and benefits beyond individual agencies and how to instigate collaboration between stakeholders to develop financing strategies to do so. These comments notwithstanding, I have some concerns in regards to the Introduction and Methodology Sections.

The introduction begins by identifying threats to urban water supplies in the western United States, including climate change and rapid population growth, specifically within the state of California. They immediately focus on the need for water resources managers in that state to reconsider their water supply and demand priorities in the face of the increasing risk of water scarcity. Although California provides an excellent example of the problem at hand, water stress in urban areas, due to increased water scarcity and unsustainable water resources management, is not isolated to the western United States. Immediately introducing the situation in California distracts from the wide applicability of the authors' research to areas outside the United States that are experiencing similar stresses on urban water supplies. This can be improved by first identifying the global need for a paradigm shift towards more holistic water resource management strategies, and then introducing California's issues and how it provides

an excellent case study to test the author's sustainability framework. Secondly, the introduction lacks a literature review on existing sustainability frameworks and justification of why a new framework is needed; existing frameworks and their faults are instead mentioned in Section 2 ("Methodology: urban water sustainability framework"). A literature review on existing frameworks should be presented in the introduction so as to identify previous work done and to identify the knowledge gap - the need for an improved framework to critically analyze limitations of water supply portfolios. Section 2 reads, somewhat, as both a continued introduction and as a methodology section. I suggest separating the introductory components from the methods to make the presentation of the methods more concise and clear (see comments 1 and 2). As for the actual methods in Section 2, there are three issues that need to be addressed. First, although the authors present the equations in an accessible way to those less familiar with complex mathematics, more information is needed on what units or values should be used as inputs (eg. volume of water) for the components in the indicator equations (see comment 3). The inputs need to be clear to ensure the reader understands how to properly calculate the indicator values. Secondly, some of the names of performance indicators used to calculate equations 9 through 11 are named differently from how they are presented in equations 1 through 8 (see comment 4). This inconsistency is also evident in Table 2 (see comment 5). The inconsistency in names reduces the clarity of how the equations for each component are used in the final sustainability index equations and it reduces the ease in which readers can quickly reference back to past equations. Finally, more attention is needed on how and why the Gini-Simpson index was used in the framework. Given the emphasis of its novelty in the introduction and conclusion as an "innovative method to measure water supply diversity", the description of the Gini-Simpson index is not given sufficient attention. The authors do not provide an explanation on the advantages and/or disadvantages of the Gini-Simpson index and why they chose it over other diversity indices used in biodiversity research (e.g. Shannon diversity index) or indices from other disciplines. They also do not clearly identify how they adapted the Gini-Simpson index for its use in water resources management.

The comments below relate to the structure of the article, clarity of the methods, consistency of terms, acronym use in tables and figures, and grammar.

Comments 1. Page 11295, lines 3 to 17 in Section 2.1 ("Framework Component"): This is not a method and does not read as an introduction to a method section. I suggest that this paragraph, except for the last sentence on lines 16 and 17, be moved as an additional paragraph in the introduction before the outline is presented on page 11294; or as the introduction to a new subsection placed prior to the methodology section that introduces and describes the factors that affect urban water resources, and explains why the chosen management components are assessed as part of the Sustainability framework. 2. Page 11295, line 19 to 25 in Section 2.1.1; Page 11296, line 16 to 20 in Section 2.1.2; Page 11297, line 4 to 6 in Section 2.1.3; and Page 11298, line 2 to 6 in Section 2.1.4: These lines introduce why the management components and the socio-economic factors relevant to water resources management are important. I suggest that these lines be pulled from the methodology section and instead placed along with the aforementioned paragraph in comment 1. These changes would make the presentation of methods more concise and clear. 3. Page 11296 to 11297: It is unclear what should be used as an input for the components used in the indicator equations (Eqn 1 through 6) because units are not given and it is not clearly stated what all the components are based on. One would assume water use is based on volumes of water, but what are conservation potential and augmentation potential based on? Table 2 shows calculated values for conservation potential and for augmentation potential on a scale of 1 to 10 - how was this done? Or were the headings in table 2 incorrectly named (see comment 1 under tables and figures)? 4. Page 11299, line 10 to 14: The names of some of the performance indicators used to calculate equations 9 through 11 are named differently from how they are presented in equations 1 through 8. "Vulnerabilityi" in Eqn 9- is this supposed to be "supply vulnerability (Eqn 1)? "Water use per capitai: in Eqn 10- is this supposed to be "Demand (Eqn 3)"? "Conservationi" in Eqn 11- is this supposed to be "Future conservation capacity (Eqn 4)"? "Augmentationi" in Eqn 11- is this supposed to be "future augmentation capacity (Eqn 5)"? This

inconsistency in names reduces the clarity of how the equations for each component are used in the final sustainability index equations and it reduces the ease in which readers can quickly reference back to past equations. Being consistent with names or referencing the equation number of each component in equations 9 through 11 will improve this issue. 5. Page 11301, line 13: Changing the units of volumes of water from the imperial system to the metric system, will improve the accessibility of the content to an international audience. 6. Page 11302, line 4, 10, and 13: Hetch Hetchy is referred to three times before it is identified as Hetch Hetchy reservoir in line 14. Qualifying Hetch Hetchy in line 4 or 10 with reservoir will clarify whether the author is referring to the reservoir or the RWS. 7. Page 11310, line 9 to page 11311, line 4 in Section 4.4 ("Sustainability Index"): I suggest this paragraph be placed under its own subheading, "Regional Scope", so as to stay consistent with the sequence of sub-headings in Section 2 (Methodology), where the method of creating a sustainability index at the regional scope is placed under its own sub-heading. Tables and Figures 1. Table 2: The names of some of the performance indicators do not match the names used in the text of the article. "Relative Vulnerability"- is this supposed to be "supply vulnerability" (Eqn 1) on page 11296?" Relative Demand"- is this supposed to be "Demand "(Eqn 3) on page 11297? Do "Conservation Potential" and "Augmentation Potential" refer to the numerators in Eqn 4 and Eqn 5 used to determine the values of the "Future Conservation Capacity" and "Future Augmentation capacity" indicators on page 11297; or are they supposed to be the indicators themselves? 2. Table 3: The acronym AFY is not defined. 3. Figure 2: The acronym FY is not defined. "Fiscal Year" is used in Figure 5, but the acronym isn't. There should be consistency with how FY or Fiscal year is used. 4. Figure 3: line 6 on page 11303 refers to figure 3 in regards to two different districts, but the name of the districts are not on the figure. The reader must look at figure 2, which has a map with an index of the district names, to determine the names of the districts. If the figures are placed on separate pages, including an index of the district names on figure 3 will improve the ease of understanding the reference. 5. Figure 3b and 3c: The acronym GPCD is used in the figure, but it is not defined in the figure

description or anywhere in the text of the article. The acronym ISG is used in the figures, but "individual supply guarantee" in the figure description is not followed by (ISG). Grammar: 1. Page 11294, line 3, ". . ..capacity of individual water agencies urban water portfolios. . ..": "Agencies" should be agencies' because it is a plural possessive noun. 2. Page 11295, line 23 to 25, "However, as urban areas continue to grow, climate change impacts pose an uncertain future, and pre-established water rights limit availability, hydrologic analyses are only a small part of the urban water picture.": There are two parts to this sentence and it is unclear where the first independent clause ends and the second independent clause begins. Adding a semi-colon after "availability" would clarify this. 3. Page 11302, line 10 to 12, "In addition to Hetch Hetchy, other mountain reservoirs and Bay Area reservoirs as well as a water bank are managed by SFPUC to supply water to urban users": A comma should be added before and after "as well as a water bank" because it is a phrase that occurs midsentence 4. Page 11302, line 15 to 17, "Releases from upcountry reservoirs on the RWS to Don Pedro Reservoir above the irrigation districts' entitlements add water to the RWS water bank account.": A comma should be added before and after "above the irrigation districts' entitlements" because it is a phrase that occurs midsentence. The framework presented by the authors in this article will be valuable to the field of sustainability in urban water resources management; however, I believe the article requires minor revisions before it is published. I would be happy to review the article following these revisions. I look forward to reading the final product.

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