

Mini-Review

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Earth Observations and Education for the Sustainable Implementation of the Nexus Approach

DOI 10.1515/cass-2015-0021

received June 20, 2014; accepted September 30, 2015

Abstract: Water, energy and food are closely connected sectors which interact in a complex manner. Complex problems which need to be addressed in these sectors require informed decisions. The key to this information are data which need to be easily available to the decision maker. In the context of the *Sustainability in the W-E-F Nexus* conference May 19-20, 2014, the session on ‘Earth Observations, Monitoring and Modelling for the Sustainable Implementation of the Nexus Approach’ revealed institutional shortcomings and general problems in data provisioning for the water–energy–food (WEF) nexus. Key Findings of the session were that (1) integrative thinking of collaborating institutions is required to address problems in the water-energy-food nexus, (2) comprehensive and coherent data need to be made readily available, potentially through the Global Earth Observation System of Systems (GEOSS) and (3) that nexus education needs to be promoted in basic and higher education in order to ensure efficient use of coherent and comprehensive datasets.

Keywords: Earth Observations, water-energy-food nexus, data interoperability

Introduction

The complexity of the problems mankind is facing is steadily increasing. The water-energy-food nexus approach considers the interconnectedness of the three sectors water, energy and food and provides a useful framework for decision making. Building reservoirs in order to ensure energy supply, for example, impacts

the flow regime of the river downstream, is a barrier for migrating fish, and amongst other impacts decreases sediment transport which delta areas might rely on. Furthermore, the construction of a reservoir usually leads to migration of people who lost their livelihoods or homes by filling the reservoir and the change in flow regime might cause crop failures downstream as a result of loss of irrigation water. From ensuring energy or food security to water management almost all processes are affected by national trade policies, global markets, climate change and many more global and local processes which should be considered in decision making.

To insure that no unintended consequences countervail their intentions, practitioners and policy makers need to know about the potentially adverse impacts their decision might have on another sector. The basis of this knowledge is data – measurements and observations taken in the field or data derived from remote sensing. Given the interconnected nature of the water-energy-food nexus, it is vital that the information used for making these decisions is accurate, complete and widely distributed to ensure that the decision processes are broadly supported, transparent and robust. The earth observation community can play a major role to ensure that the data services developed for the water-energy-food nexus support the needs of decision makers and promote sustainability in this nexus. This report summarizes the challenges to provide data in the water-energy-food nexus, identifies current information gaps and proposes specific tools and recommendations for how to address these issues.

Summary of findings from session

The first challenge identified during the session is ensuring data provision. Relevant data for addressing the issues of the water-energy-food nexus usually exist but often are hard to find or access. This reveals a lack of communication and organization between institutions who collect data

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and decision makers who use these data. Currently the vast majority of data providing portals are scattered, unconnected and without coherent data structure or access policies. The Group of Earth Observations (GEO) is targeting to build the Global Earth Observation System of Systems (GEOSS) as a major contact point for data provision which leads towards easy access to coherent and comprehensive data products. GEO is an intergovernmental group with 90 members and 77 participating organizations. The GEOSS will be a global, open and flexible network merging contents from a wide variety of earth observing instruments and information systems providing decision makers with a huge range of information. Recently GEO obtained a mandate until 2025 to address urgent global challenges, support sustainable development and further build the GEOSS.

Besides the primal need to ensure provision of data, a second challenge is to make different datasets interoperable. This includes data of various scales, resolutions and origins. Available data products are rarely easy to merge or compare. Data derived from in situ field measurements with high temporal resolution add value to data derived from remote sensing with high spatial coverage. The GEOSS aims to combine data from different kinds of instruments on different scales in order to develop coherent data sets. This furthermore includes regional aspects to the water-energy-food nexus which at present rather is addressed on a global scale.

To effectively use the proposed data products, administrative bodies need to collaborate and work together when it comes to resource management and tackling of pressing issues in the water-energy-food nexus. An example from coastal management in Japan illustrated that 35,000 km of coastline are managed by seven different ministries which additionally to having different data requirements lack coherent management strategies. In this case, different areas are managed by different bodies which try to achieve different targets (e.g. coastal protection, facilitation of ship and boat routes etc.). Other common and prominent examples of such institutional misfit are transboundary river basins which primarily are managed on national basis. To achieve sustainable management goals, an integrated management plan needs to be developed by all parties involved. Thus the third challenge is to improve cooperation amongst administrative bodies and boundaries.

The promotion of integrative thinking in education represents the fourth challenge. The new generation of scientists, administrative officers, and industrial staff should be able to address future problems in an integrated way from the very beginning and make use of such comprehensive data products as mentioned above most effectively. Decision making needs to be shaped by integrative thinking. Basic and

higher education which addresses issues of the water-energy-food nexus is therefore strongly required. Understanding the interrelatedness of different sectors will be the key qualification of a new kind of specialists. One existing example can be found at the Technical University of Munich (TUM) where a water-energy-food nexus master's programme has been established.

Conclusions and Recommendations

The session illustrated that there is a gap between data required by decision makers and data products which are currently accessible. Precise and coherent data products need to be readily available for science and decision makers. In order to develop comprehensive datasets both, field data and remote sensing data need to be combined. The first contributes precise measurements from on the spot while the latter provides spatial coverage. To increase capacities for analysing such integrative datasets, the next generation of scientists and practitioners need to be trained in understanding the linkages of the sectors of water, energy and food. In practise management bodies need to think and work across administrative boundaries to implement nexus thinking into management practices.

Practical steps which were proposed during the session are

- Integrate decision-makers from the water-energy-food nexus into designing of earth observational services more effectively
- Establish a working group to develop ideas, approaches and project proposals that could advance work on the application of earth observations to the water-energy-food nexus framework.
- Improve collaboration of administrative bodies and institutions to ensure integrated implementation of the water-energy-food nexus across existing administrative boundaries
- Incorporate Nexus education for integrative thinking at all educational levels

This report is based on the Session A02 at the International Conference Sustainability in the Water-Energy-Food Nexus. Synergies and Tradeoffs: Governance and Tools at various Scales held in Bonn, Germany, on 19th and 20th of May 2014.

Session chair:

Richard Lawford, Morgan State University, Baltimore, United States of America

Speakers:

- An integrated map to coordinate coastal policies and water resource policies in Japan: visualizing a water, energy and food nexus presented by: Aiko Endo, Research Institute for Humanity and Nature, Kyoto, Japan
- The NeXus Water – Food – Energy project at TUM and partner universities presented by: Peter Rutschmann, Technische Universität München, München, Germany
- Using Earth Observations for Integrated Water Resources Management presented by Richard Lawford on behalf of Douglas Cripe, GEO Secretariat, Geneva, Switzerland
- Using Earth observations to address the basin-scale information needs of the Water- Energy-Food Security Nexus presented by: Richard Lawford, Morgan State University, Baltimore, United States of America