Report cards and system dynamics modelling

A novel approach to advance management and health of river basins

This newsletter captures the joint vision developed by participants at a workshop held in Annapolis, Maryland in November 2016. The aim of the workshop was to investigate opportunities to advance the management and health of river basins by combining two previously independent approaches – Environmental Health Report Cards and System Dynamics Modelling. These approaches were respectively pioneered by the University of Maryland Center for Environmental Science (UMCES) and the University of Bergen. The synergistic impact of merging these two approaches was discovered through new partnerships between UMCES, WWF, Luc Hoffman Institute, Humboldt Institute, Royal University of Phnom Penh, and KnowlEdge SRL - all represented at this workshop.

Approach 1: River basin health grading

Report cards are stakeholder driven assessments and communication products that compare environmental, social, and/or economic information against predefined goals or objectives. Like school report cards, basin health report cards provide performance-driven numeric grades or letters that reflect the status of a river basin on a regular basis. They effectively integrate and synthesize large and often-complex information into simple scores that can be communicated to decision makers and the public.

Approach 2: System dynamics modelling

Systems thinking is used to engage stakeholders and create a shared understanding of the main drivers of change in the system. The result of this exercise is the creation of a Causal Loop Diagram that shows how social, economic and environmental indicators are interconnected. System dynamics models quantify the linkages between these environmental, social, and/or economic variables. Quantification of these variables and relationships into a working model enables generation of future scenarios based on different management and policy decisions.



The Orinoco River Basin Report Card was created in Colombia by WWF Colombia, WWF US, and UMCES with contributions by many stakeholder groups.



This causal loop diagram was created for the Mekong Flooded Forest in Cambodia by LHI and the LIVES project.

Rivers need the next generation of management solutions

Rivers and river basins represent the world's most precious resource - freshwater. Despite the massive role freshwater plays for people and nature, it is a surprisingly finite and threatened resource. Less than 1% of the world's water is fresh and accessible.

Climate change, population growth, pollution and changing consumption patterns are just a few of the myriad of forces putting freshwater systems increasingly at risk. Conversely, limited resources to address these pressures calls for a new set of tools to produce well-balanced sets of policies that can lead to solutions to the grand challenge of improving freshwater resources at a global scale. Combining the strengths of report cards and system dynamics models, we envision an approach that forecasts the effectiveness of future management scenarios on freshwater resources and river basin health.

FRESHWATER FOR HEALTHY COMMUNITIES

Clean, fresh water is an essential ingredient for a healthy human life, but 1.1 billion people lack access to water and 2.4 billion don't have adequate sanitation. Diseases caused by unsafe water and inadequate sanitation kill more people every year than all forms of violence, including war. Sustainable access to fresh water and sanitation leads to healthier people and economic growth, which facilitate improved environmental

FRESHWATER FOR NATURE

management.

Freshwater ecosystems support more than 125,000 species and provide a myriad of ecosystem services. However, more than half of the world's wetlands have disappeared since 1900, and fewer than 70 of the world's 177 longest rivers remain free of man-made obstructions.

FRESHWATER FOR FOOD

Globally, agriculture uses the highest percentage of freshwater, accounting for about 70% of total water withdrawals. While most of the water goes to irrigation, it also helps provide the energy and ecosystem services required for farming. Freshwater fish also provide an important source of protein

and livelihoods for millions of people around the world. As the planet's population increases and consumption patterns change alongside economic prosperity, global demand for food will increase.

FRESHWATER FOR BUSINESS

Nearly every business is water-dependent in one way or another. In 2014, the World Economic Forum's annual Global Risks Perception Survey ranked water crises third among 10 global risks of highest concern. Issues of water scarcity and poor water quality have significant and growing social, environmental and economic consequences.

FRESHWATER FOR ENERGY

Energy and water are linked. Energy is required for pumping, storing, transporting, and treating water, and water is essential for producing almost all kinds of energy. While the role of water in hydropower is clear, water also irrigates biofuels, plays an essential role in fracking, and cools thermoelectric power plants like coal, nuclear, natural gas, and oil. All of these methods of energy production can have serious environmental and social consequences.

Moving beyond environmental status and function

Report cards, to date, have included recommendations that the public, policy makers and government can implement to improve the status of a river basin. Despite the strong scientific rigor used in developing report cards, recommendations on how to improve grades are based primarily upon expert opinion and a basic understanding of the connections between indicators within a river basin. System dynamics modelling provides a mechanism to augment and quantify our understanding of connections between indicators, enabling varied management scenarios to be run, leading to more confident recommendations on what actions will have the greatest positive environmental outcome.



Report cards provide information on the status of a river basin and system dynamics models describe how a river basin functions. By merging these methods, there is potential to forecast system response to different management and/or climate scenarios.

Identifying actions that will lead to desired environmental, social and economic outcomes

Integrating report cards and system dynamics modelling will enable future scenarios to be tested under different management and climate conditions. This will enable identification of the optimum cost:benefit solution for achieving desired environmental, social and economic goals.



Report cards are effective at tracking the status of basin health over time, including post-analysis of management interventions. System dynamics modelling provides potential to assess the efficacy of different management interventions prior to them being funded and implemented.

A proposal to realize this concept

A proof of concept exercise is proposed to integrate report cards and system dynamics models. It is proposed that this demonstration be conducted in an information-rich area that has existing report card grades (e.g. tributary of Chesapeake Bay) enabling future grades to be forecast under different management and/or climate scenarios.

Testing the proof of concept in an area with existing report card grades will enable calibration of the model with historical grades via backcasting against reality. This proof of concept exercise will use existing data, report card grades, and knowledge held by the research teams in order to illustrate a real-world example of past, present, and future report cards. This illustration will be the cornerstone of implementing this approach in other river basins around the world.

Workshop representatives from WWF Cambodia and WWF Colombia expressed interest in adopting this new approach to improve basin management of the Mekong and Orinoco Rivers - pending the success of the proof of concept. Workshop bringing experts in report cards and system dynamics modeling together

Test proof of concept

Prepare and publish peer reviewed article

Showcase newly developed approach

Adopt new approach for river basin assessment and management

Acknowledgments

This newsletter summarizes the outcomes of a workshop exploring linkages and potential benefits of combining river basin health report cards and system dynamics modelling. The workshop was held November 9-11, 2016 in Annapolis, Maryland, United States.

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