



THE HARVARD WATER PROGRAM: Science, Technology and Policy for Water Security¹

(Working Draft of December 2010)

1. The problem:

Economic and population growth mean an ever-greater demand on finite water resources. Many countries already face major threats to their water security and thus to their ability to provide people with safe drinking water and food, to produce energy and sustain economic growth and to enhance environmental quality. Climate change greatly amplifies the water insecurity of many countries. (A simple description of the challenge of climate change is that mitigation is about energy and adaptation about water.) Addressing this challenge requires new knowledge on technologies and institutions, and a new generation of “specialized integrators” who can simultaneously drill deep in their own disciplines and work across the many disciplines required to address the challenge of water security.

2. The Vision:

The Harvard Water Program will undertake a major program of world-class inter-disciplinary research which will enable policy-makers to better understand the water threats they face, and to identify new and better tools (technologies, policies and institutions) to address the water challenge. The Program will train a new generation of “specialized integrators” who have deep expertise in their disciplines and are also capable of integrating across disciplines. The Program will thus have a major educational component for undergraduates, graduate students and post-doctoral fellows.

3. What Harvard can bring to the table:

Harvard has a proud tradition – the famed Harvard Water Program of the 1960s – in path-breaking interdisciplinary work on water, involving primarily engineers, economists and political scientists. MIT will also be closely involved in the initiative either through individual faculty members, or as part of a larger Harvard/MIT joint initiative. MIT has long been a world leader in water management and technology issues. Harvard and MIT have, together, world-class faculty in most of the relevant disciplines as is evident from the list of faculty who might engage (see annex.)

4: How the Program will operate in Cambridge:

The Program aims to create a new generation of “specialized integrators” who are deeply immersed in their disciplines but also learn what other disciplines have to offer and how to work with multi-disciplinary efforts. The Program will thus work with a number of other ongoing programs in Cambridge, of which the following are some examples:

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- With the Environmental Governance Initiative spearheaded by Prof. Jody Freeman at the Harvard Law School;
- With the Harvard University Center for Environment, headed by Prof. Dan Schrag;
- With the Harvard Kennedy School Sustainability Science program headed by Prof Bill Clark.
- With the Harvard Business School's Environment for Business Program headed by Prof Rebecca Henderson and Forest Reinhardt (where the idea is to engage the private sector, both global and local, in both the development of new water-related technologies (for example, biotech, nanotech and IT) and in engagement in innovative ways in helping governments improve the legal, regulatory and management practices which affect water security).

The idea is to position Cambridge as “the place” where government and private sector leaders engage for two days each year in assessing the institutional and technological frontiers and challenges, and in defining priority areas of applied soft and hard research needed to improve water security.

5: How the Program will operate with external partners:

“Horizontal” partnerships between Harvard and major research intuitions in other countries will be a central feature of the Program.

Track One will involve major multi-disciplinary collaborative partnerships between Harvard and MIT scientists and inter-disciplinary groups of scientists in world-class research universities in about six countries which face major water security challenges (initially Brazil, Pakistan, Australia, Mexico and the United States).

Track Two will involve discrete partnerships on specific water issues with other countries where Harvard and MIT faculty and students are engaged. An initial, partial, list includes South Africa, Cyprus, Jordan, Bangladesh, India, China, Kenya and Ghana). (It is hoped and expected that several countries will move from Track Two to Track One as we have further discussions with potential counterparts.)

6. The (initial) partner countries:

The initial idea is to initiate major water partnerships, starting with six countries: Brazil, Australia, Pakistan, the United States, South Africa and Mexico. The potential partner countries are chosen (a) because they all have strong scientific capacity which makes a horizontal research and training partnership possible; and (b) because they all face major water challenges and (c) they represent a range of environmental challenges – including mountains (the Himalayas in Pakistan), forests (the Amazon in Brazil) and arid lands (Australia, South Africa and Mexico).

6. The research domains and how faculty at Harvard, MIT and partner institutions might participate:

A first area of focus will be on **the history of water and society**, since social, cultural and religious understanding form the mental terrain on which all changes in water management practices must be built. Faculty members in Harvard's History and Anthropology Departments and MIT's Urban

Studies department have done seminal work on the history of water and on social norms regarding water, and will engage with partners in “focus countries” in this project.

The second area of focus will be to characterize **the changing exogenous water security environment**. In most cases this will include the effects of climate change on hydrology. In some ways Australia is at the forefront of this process, for it has seen dramatic reductions in rainfall over the past decade. Looking forward, much of the economy of Brazil depends on benign rainfall patterns, which are linked to local moisture circulation provided by the Amazonian forest and may change with deforestation. And Pakistan is a country built around one river, which depends heavily on both (retreating) Himalayan glaciers and changing monsoon rainfall patterns. MIT has long-standing strengths in both climatology and hydrology, and Harvard faculty in Earth and Planetary Sciences and Biology are deeply engaged in climate change research and keen to extend that work to deal with hydrology. A number of the partner countries have major scientific programs on climate change, but in all cases closer integration of climate change and hydrology are vital.

In some countries the exogenous water security environment is also closely related to broader inter-national political circumstances. Pakistan’s water, for example, mostly comes from India, China and Afghanistan. Faculty in Harvard’s Center for International Affairs and the MIT/Harvard Law School Negotiations Project have interest in engaging with partners on international and inter-state aspects of water security.

The third area of focus is on **tools which can be used within countries to manage water-related risks**. These include: the design of crops which are better able to tolerate water scarcity and salinity (faculty in the Biology Department); the design of crop and rainfall insurance schemes (Business School); the development of instruments including regulation, water markets and output-based incentive schemes (Economics Department, Law School and Kennedy School of Government); alternative dispute resolution techniques (the Harvard/MIT Negotiations Project); smart infrastructure for the management of water (Harvard and MIT Schools of Engineering); new technologies for treating and measuring water (the Chemistry Department at Harvard, and the Schools of Engineering at Harvard and MIT), mechanisms for improving water quality and protecting populations from poor water quality (MIT Engineering Department, School of Public Health and Kennedy School faculty).

The fourth area relates to **the consequences of water management**. This includes the economic impact of adaptation to climate change, better natural resource management and infrastructure (the Kennedy School) and the push and pull impact of water on migration (the School of Public Health).

7. The identification of specific research topics:

This is being done through structured processes whereby groups of Harvard/MIT faculty engage collectively and individually with government, the private sector and research counterparts in identifying areas of research which are critical for water security and of mutual scientific interest. This has included discussions involving Harvard and MIT faculty with counterparts in Pakistan, Brazil and Australia and the identification of areas where there is mutual interest in both research and education.

8. Leadership

Under the leadership of Professor John Briscoe, Harvard is committed to bringing together outstanding faculty from the University to advance the intertwined global issues related to water, food, energy and health security. John Briscoe is Gordon McKay Professor of the Practice of Engineering and a faculty member at the School of Engineering and Applied Sciences, the School of Public Health and the Kennedy School of Government. His career has focused on the issues of water, other natural resources, and economic development. Before joining the Harvard faculty he was with the World Bank, where his last assignments were as Senior Water Advisor in Delhi and Country Director for Brazil. He has lived in his native South Africa, India, Brazil, the United States, and Bangladesh and worked on water issues in these and many other countries.

9. Potential Partners:

The water security challenge has both institutional (broadly defined, to include laws, regulations, incentives, organization and business models) and technological dimensions. Government is obviously key to creating a sound institutional environment, and thus will be a major partner. Private companies have a growing interest in water, both because the lack of a clear legal and regulatory environment constitutes a threat to their social license to operate, and because many of the technological solutions (biotechnological, chemical, measurement and information) will come from the private sector. Accordingly the Program will engage with the private sector as a group interested in both solutions and knowledge. The Program will also seek to engage NGOs, ranging from those who create awareness to those who engage in finding solutions. Finally, the collaborative research process will mean that universities and other research institutions in the focus countries will be equal partners.

10. Countries where talks on partnerships are advanced:

Brazil

Brazil is a continent-sized country with wide regional variations in climate and economic development and, accordingly, water management challenges. Some of the initial list of potential research collaboration involving Brazilian and Harvard scientists include:

- the effect of climate change and deforestation on the hydrology of Brazil;
- the risk these hydrologic changes pose risks for agriculture, energy and water for cities and people;
- the roles of different risk mitigation tools (biological, technological, institutional, economic, financial)
- institutional arrangements which could make river basins engines of economic development in the under-developed North and Northeast of Brazil;
- the role of public-private partnerships for stimulating inclusive irrigation in the Northeast;
- the development of a new palate of economic analysis tools for the analysis of major water infrastructure, which would focus on constraints to growth and identify critical complementary investments and policies;
- the application of innovative analytic, regulatory and financial instruments for the cost-effective reduction of contamination from urban and industrial wastewater in metropolitan areas;

- the health consequences of major developments in the Amazon, and policies for risk mitigation;
- the role of material science (membranes, nanotechnology) in improving water and wastewater treatment and water re-use;
- the public health risks from emerging contaminants in various environments – metropolitan areas, mining and agriculture – and technical, regulatory and monitoring responses to these.
- The role of Brazil’s “new multinationals” in addressing water issues in Brazil and the developing world.

A number of Cambridge faculty – in biology, earth and planetary sciences, engineering, business and public health -- have long-standing related research projects in Brazil, while Harvard’s David Rockefeller Center for Latin American Studies has an office in Sao Paulo.

Brazil has great professional capacity in hydrology, agriculture, meteorology, energy, economics and health sciences. There is a high degree of interest from key Federal institutions (such as the National Water Agency, the National Space Institute and EMBRAPA, the national agricultural research institute), from key State Governments, from the major universities, and from major private sector actors. The School of Engineering at the University of Sao Paulo (Brazil’s leading university) has established a Water Policy Program which will act as the principal counterpart to the Harvard Water Program

Australia

Over the past twenty years Australia has become the global leader in all dimensions of water-related research, policy, and practice and has integrated these fields to great effect. Over the past decade this capacity has been put under severe test by an unprecedented drought. This has led to massive innovation and a major research effort involving a wide range of disciplines.

Australia has strong human resources in the water sciences and practice. Australia’s leading university – Melbourne University – has a major multidisciplinary water program led by one of Australia’s foremost water experts and acting in a consortium with Monash University.

A group of Harvard faculty (from the Schools of Engineering, Government, Kennedy School, Biology, Law and Public Health) visited Melbourne in June 2010.

One specific research project was initiated and has funding. This is a joint effort of the Committee for the Economic Development of Australia, Melbourne and Monash Universities, Harvard and McKinsey and Company. Over a two-year period the consortium will address the following questions: (1) what has the impact of the market-based water reforms on the economy and the environment? (2) what new types of management instruments should be developed and applied to deepen the economic impact and to improve environmental outcomes? (3) what portfolio of instruments will be needed by the new State and Commonwealth Environmental Water Holders? (4) what is an appropriate set of assets (infrastructure and entitlements) for cities?

Other areas of collaborative research that are being explored include: the impact of land-use changes induced by man and climate change) on hydrology and the aquatic environment; the likely response of aquatic ecosystems to different environmental watering regimes; the impact of climate

change, land use changes and water use changes on emerging contaminants, and the implications for human health.

Pakistan

Since its birth, Pakistan has faced grave water challenges. Chief among these has been obtaining access to the headwaters of the Indus and rivers of the Punjab, whose headwaters were, at the stroke of a British pen, committed to other countries. A second major challenge has been dealing with waterlogging and salinity in the world's largest contiguous irrigation system. [This problem led to a long and highly productive relationship with Harvard, which started in 1963 when Pakistan's President Ayub Khan asked U.S. President John F. Kennedy for help. The multidisciplinary team from the Harvard Water Program was mobilized and worked closely with Pakistani experts to devise a solution to what seemed to be an intractable issue. Key MIT faculty also have had major engagement in water management in Pakistan.] A third challenge is to build infrastructure and institutions which can maximize welfare and manage risk from floods, droughts and environmental degradation.

Today, Pakistan faces a stark challenge in dealing with variability of both the excess variety (as demonstrated in the catastrophic 2010 floods) and the scarcity variety, where water managers face "Malthusian-plus" challenge of dealing with rapidly growing water demands (water for energy, agriculture and people, and protection from floods) from a resource base that is likely to change substantially as the glaciers of the western Himalayas melt and monsoon patterns change.

As might be expected for a country which depends on one river, Pakistan long has had outstanding water and water-related professionals. A number of Harvard/Pakistan meetings have taken place in Islamabad and Lahore in 2009 and 2010. There is a high degree of interest in the Federal and State governments of Pakistan, the Higher Education Commission, major research institutions (such as the International Water Management Institution and the Lahore University of Management Sciences), major NGOs (including the Aga Khan Foundation), international and bilateral development agencies and the multinational and domestic private sector. Harvard is engaging jointly with faculty from MIT and the University of Nebraska. Some of the ideas which are being explored for joint research on water security in Pakistan include:

- How climate change will affect the Himalayan glaciers and how both will affect the quantity and timing of river flows
- The design of a modern institutional and infrastructure system to deal with both historic and emerging variability (as expressed in droughts and floods)
- Development of a modern decision support system, including a new Indus Basin Planning Model
- Options for a re-invigorated Indus Water Treaty (IWT) and for a Pakistan-Afghanistan Treaty on the Kabul River
- Developing a vision and plan for making Pakistan into a regional agricultural superpower, starting with the Province of Punjab, where the focus will be on development of a demand-driven irrigation system, implementing emerging water entitlement systems and exploring the role of next-generation crops and constraints to their implementation.
- Developing a sustainable water future for a major city (initially Lahore) – which will include assessments of both supply and demand options, options for re-use, and health implications.

Mexico

Mexico faces a host of water challenges. The initial focus of a partnership with Harvard will be working with the Universidad Autonoma de Mexico (UNAM) on the multi-pronged issue of water re-use for metropolitan Mexico City. Among the challenges to be addressed are: the health consequences of formal re-use; the role which re-use can play as a long-term source of water for urban, industrial and agricultural uses, and the legal and regulatory instruments which might be used. A particular plus for a relationship with Mexico is the strong presence of Mexican leaders on Harvard's faculty, and the ease of engaging students.

The United States of America

Like many of the other countries, the United States is a big country with very diverse water challenges. Harvard is exploring two areas of partnership with US institutions.

The first is with the Mississippi River Commission, where the idea is to engage Harvard students with the Commission itself and its many partners in addressing the related issues of flood control, navigation and integration of environmental and economic objectives. This partnership opens excellent opportunities for field-work by undergraduate and graduate students in the Mississippi basin.

The second partnership in the United States is with the Water for Food Initiative at the University of Nebraska at Lincoln. This is attractive because of the University of Nebraska's deep skill base on issues of food and water. This partnership would operate both in Nebraska (where it would provide field-based learning for Harvard students in a state which has the largest irrigated area) and in countries of mutual interest (with a partnership currently being explored in Pakistan).

10. Funding Strategy

Harvard envisions a major, long-term engagement in the area of water security. The Program has initial commitments to five-year funding -- to \$2 million from an anonymous donor and \$1 million from Pepsico.

Addition funding will be sought from governments, foundations, companies and private individuals, in three forms. Funding will be sought for specific research topics in specific places (such as effect of glacier melt on hydrology of the Indus River); on overall country programs (such as for the Pakistan program); on specific themes in different countries (such as the use of information technology) and for the overall Harvard Water Program.

Annex: [An initial list of faculty at Harvard and MIT who might engage](#)

Faculty Member	Discipline	Areas of potential engagement	School
Allan Hill	Demography	Migration	School of Public Health
Anne E. Monius	Religion	South Asia religions and water	Harvard Divinity School
Charles Harvey	Hydrology	Groundwater management	School of Engineering, MIT
Colleen Hanzel	Geochemistry	Mining and other waste mitigation	School of Engineering/Applied Sciences
Christian Werthmann	Architecture	Urban planning and design	Graduate School of Design
Dara Entekhabi	Water Resources	Water and Climate	Parsons Lab, MIT
Dan Schrag	Climate change	Climate change and hydrology	Dept of Earth and Planetary Physics
David Blackbourn	History	Water management and history	History Department
Dennis McLaughlin	Engineering	Systems analysis at the basin level	School of Engineering, MIT
Forest Reinhardt	Business	Water and business	Business School
George Whitesides	Chemistry	New chemical treatment technologies	Chemistry Department
Gunther Fink	Economics	Water and health	School of Public Health
Henry Lee	Government	Water utilities and regulation	Kennedy School
James Shine	Aquatic science	The aquatic environment	School of Public Health
James Westcoat	Urban Studies	Water policy	Urban Studies, MIT
Jennifer Roberts	Art History	Art and water	Art and Art History
Jody Freeman	Law	Environmental Law	Harvard Law School
John Lienhard	Mechanical Engineering	Membranes, desalination	Mechanical Engineering, MIT
Lant Pritchett	Economics	Institutions	Kennedy School of Government
Larry Susskind	Law	Dispute resolution	MIT Urban Studies
Marcia Castro	Epidemiology	Malaria and water	School of Public Health
Megan O'Sullivan	Government	Water and conflict	Harvard Kennedy School
Merilee Grindle	Government	Institutions and public policies	Government
Michael Hiscox	Government	Institutions for resource management	Government
Michael Kremer	Economics	Water and health	Economics
Missy Holbrooke	Biology	Plants and water	Faculty of Arts and Sciences
Paul Moorcroft	Biology	Effects of land-use change on climate	Faculty of Arts and Sciences
Peter Huybens	Climate change	Climate change and hydrology	Faculty of Arts and Sciences
Peter Rogers	Water Engineering	Water policy and systems analysis	School of Engineering/Applied Sciences
Ricardo Hausmann	Economics	Water and economic growth	Kennedy School of Government
Richard Cash	Public Health	Water and health	School of Public Health
Robert Stavins	Economics	Climate change and water	Kennedy School of Government
Richard Freeman	Economics	Economics of innovation	Economics Department
Scot Martin	Aquatic chemistry	Water in the aquatic environment	School of Engineering/Applied Sciences
Sean Cole	Finance	Crop and rainfall insurance	Business School
Steven Caton	Anthropology	Behavior and water	Anthropology Department
Steven Wofsy	Climate change	Climate change and hydrology	School of Engineering/Applied Sciences
Sugata Bose	History	History and water institutions	History Department
Susan Murcott	Engineering	Low-cost technologies	Engineering, MIT
Tony Ibanez	Government	Water utilities	Kennedy School of Government
William Clark	Ecology	Water and the environment	Kennedy School of Government
John Briscoe	Engineering	Water policy	Engineering, Public Health, Kennedy School