

## Interlinking of rivers: A climatic viewpoint

A highly ambitious and massive water project that would integrate most of India's major waterways at a cost of more than US\$ 100 billion<sup>1</sup> has become a topic of intense debate in the scientific and policy-making communities. Interlinking of rivers, although primarily aimed to mitigate problems of floods and droughts in different regions of the country, is also correlated with positive implications to energy- and transport-related industry, as well as with the agriculture and human health sectors. It is said that apart from addressing the problems of floods and water scarcity, this project has enormous potential to deliver advantages such as substantial and cost-effective hydroelectric power, enhancing food security, and an alternative transport system of navigable waterways, claimed as more efficient and effective than the present road system. It is also argued that it will help to reduce job-seeking migration from rural to urban areas, as it is expected that the interlinking of rivers will create numerous local jobs. However, critics identify several problems. They cast doubt on its financial and socio-political implications, emphasize rehabilitation problems, and highlight uncertain impacts for soil and other ecosystems. They also speculate about increased water logging and new breeding grounds for mosquitoes and epidemics, such as malaria. Instead of mega-engineering, they support practical ways to use local water, including decentralized irrigation, rain-water harvesting, groundwater recharging, and recycling and re-using wastewater.

Rivers, the natural channels for water, carry various nutrients and minerals. They modify local microclimates, including temperature and humidity. Any large-scale change in their course will eventually change the patterns in which these environmental entities flow and give shape to the existing local and regional-scale climate systems. It cannot be denied that environmental assets, e.g. air and water quality, soil fertility, nutrient cycles, and climate have real values. These environmental public goods are, in fact, key constituents of sustainable development. It is, therefore, important to ensure that these entities are used and managed wisely to maximize long-term improve-

ment in living standards. For this purpose, their inter-relationships within the framework of interlinking of rivers need to be comprehensively studied. In other words, the values of these environmental assets need to be considered as guiding factors to set clearly integrated and attainable objectives of the present multidimensional project. Although a simulation study is said to be underway to help align canals, locate suitable sites for dams, and avoid areas of likely ecological damage<sup>1</sup>, it is not sure that the long-term local and regional scale impacts on hydrologic, atmospheric and nutrient cycles, and climate have yet been sufficiently considered. The hydrologic, atmospheric, and the integrated climatic impacts of this mammoth project need proper attention, including from the perspective of the Asian Brown Cloud<sup>2-4</sup>, a phenomenon which last year made headlines in national and international newspapers.

Interestingly, the overall impact of interlinking of rivers on regional climate may be constructive. It is because this project is estimated to produce substantial amount (up to 34 gigawatts<sup>1</sup>) of non-polluting hydroelectric power and allow the substitution of a great number of fossil fuel-based transportation systems that currently cause considerable air pollution. The reduced particulate pollution might improve the regional air quality while saved greenhouse gas (GHG) emissions could impart benefits from the global climate change perspective. Thus, the interlinking of rivers is likely to play a significant and at least partially environment-friendly role in meeting the increasing energy demand of an expanding population and economy of India. That would otherwise be met in the long run by the consumption of additional fossil fuels as well as bio-fuels, which emit substantial amount of air pollutants and trace gases responsible for deteriorating ambient air quality, by reducing oxidizing power of the atmosphere<sup>5</sup>. In turn this will influence the solar radiative balance and alter local and regional climate systems.

Moreover, it would be interesting to learn how this project, with a potential to annually irrigate an additional 35 million hectares<sup>1</sup> of agricultural land will influence regional carbon and nitrogen cycles.

A carbon sink is created when plants remove carbon dioxide (CO<sub>2</sub>) from the air through carbon fertilization effect<sup>6</sup> and store it in their tissues<sup>7</sup> or in the soil as organic matter. Also, better practices in the agricultural sector can reduce CO<sub>2</sub> emissions to the atmosphere<sup>8</sup>. It is, therefore, likely that the substantial increase in agriculture activity that this project entails will enhance the carbon sink capacity within India (assuming better agricultural practices are adopted), but at the same time it also increases emissions of nitrogen compounds<sup>9,10</sup> and methane<sup>11</sup>. Nitrogen compounds and methane may change the ozone budget that have the potential to further intervene in the oxidizing capacity of the atmosphere through hydroxyl chemistry<sup>12</sup>. These chemical species are also known as greenhouse gases with the capacity to change the climate. However, until an extensive scientific study is carried out to quantitatively estimate and evaluate such impacts using different possible scenarios, one cannot say how the possible influences of this project will be distributed geographically and on a long-term time scale. Results from such a study may offer insights to help design the layout of waterways to interlink existing rivers in climate-friendly ways, to adopt and to enhance appropriate agricultural practices<sup>13</sup>, and to mitigate ill effects while enhancing probable positive influences.

Along with other important studies (e.g. socio-economic, ecological and public health impact assessments), hydrologic and climate impact assessment of such a mega civil engineering project linking 37 rivers through a maze of 30 canals totalling 12,500 km in length<sup>1</sup> warrants study. In addition, how current trends in global climate change may affect future Indian rainfall, Himalayan glaciers, and flow of rivers need to be investigated. This gigantic intervention in natural watercourses is also likely to have geo-political implications. Already, neighbouring Bangladesh has expressed concern over the management of rivers that drain into its territory<sup>14</sup>. A holistic and transparent impact assessment study of the project on interlinking of rivers would not only prove to be a milestone in the area of science and policy inter-

face research, but also serve as a means to inform various stakeholders of its implications.

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## Ph Ds and the development of a research culture in Indian universities

The editorial on the quality of Ph Ds produced by our universities draws attention of the scientific community to a matter of great concern<sup>1</sup>. The month of December 2002 saw a steep rise in the number Ph D theses submitted to the universities in Maharashtra. This may be a record compared to previous years. Interestingly, a good number of the theses were by the lecturers employed in universities and colleges. This means, soon highly qualified lecturers may teach more and more number of our postgraduate students. This seems to be a happy development. It should be so in PG centres and universities. What is the reason for this sudden upward trend in Ph D submission raising the curve of Ph D submission further? Who ignited the spark for investigation in the minds of these people? The actual reason was an announcement that those who submit their Ph D thesis by December 2002 will be exempted from clearing the National Eligibility Test (NET) or State Eligibility Test (SET). This announcement gave one more opportunity to escape from appearing for NET/SET examination for those who are in service. We cannot blame those who could beat the deadline. There is nothing wrong in beating a deadline by working hard and without compromising on the quality. But what most of the people did was to make use of the sloppy system of conducting and awarding Ph D degrees existing in most of our universities. All of a sudden

where does all this data come from? What is the fate of the data contained in these theses? What is the quality of these data? Where will it be published? How much will it further our knowledge? These questions are not only relevant to the December theses but also to all the doctoral theses submitted to our universities. Surprisingly, these questions are rarely posed or answered. Or if posed they are never seriously taken because by doing so we will be challenging an existing system well-rooted in our universities. The reality is that data in many of these theses may not even see the light of the day nor may enlighten any. They may merely decorate the library or personal shelves of the authors.

The current system of conducting Ph D research and awarding degrees existing in majority of our universities has resulted in developing an inferior research culture. The system has passed on a bad message to young aspirants. The sincere attempt made by the UGC and our visionaries on higher education to improve the standard of higher education by encouraging teachers to qualify for doctoral degrees through incentives or through enhanced fellowships is being made futile. This is not just a December syndrome but a common practice. The introduction of a qualifying examination for junior research fellowship and enhancement of fellowship by the UGC and CSIR was a right step. This has attracted better stu-

dents to research and provided support to poor students. However, it is not mandatory to pass NET to be a research student. A good percentage of Ph D research is being done by non-NET candidates and guided by ill-trained supervisors. There is no condition that papers need to be published out of a doctoral thesis. Many times the candidates and their supervisors are satisfied with abstracts in some obscure conferences. It is easy to find supervisors who have no publication record in refereed journals. Plenty of supervisors are available even in places where basic amenities for research are lacking. How can we prevent recognized guides from guiding and producing Ph Ds?

The way research is conducted and Ph Ds are awarded in our institutions needs to be reviewed. Development of norms need not be from scratch. They already exist in good universities whose practices can be followed. This will greatly contribute to developing a healthy research culture in our country.

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