Assessing policy influences on people's relationship to water ecosystem services: The Indian experience

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Report contributing to the scoping exercise managed by IIED to help develop a DFID research programme on water ecosystems and poverty reduction under climate change

International Institute for Environment and Development

Executive summary

Projections of water demand indicate, according to the Ministry of Water Resources, that India will be able to meet her water requirements until the year 2050 through integrated water management plans. This may be an unrealistically rosy picture, as two crucial factors have not been taken into account: the impact of programmes such as watershed management programmes, and any possible impact due to climate change. Further, there has been no attempt to enumerate the ecosystem services being provided by these freshwater ecosystems.

The National Water Policy makes recommendations that could address many of the problems in the water sector – however, few of them have been implemented effectively. The Environment Policy 2006 is the only recent policy provision to address issues such as climate change and its impact but it will be interesting to see as to what extent these recommendations shall be implemented in practice.

Watershed development guidelines, most recently revised as the 'Hariyalli' guidelines in 2004, present useful and legitimate objectives (apart from the objective to harvest every drop of water, which does not acknowledge the potential lack of supply to downstream areas). However, implementation reflects inadequate application of hydrological principles, and perhaps too much focus on (sometimes unjustified) expenditure. Integrated watershed management would benefit from a framework to include both administrative and hydrological linkages, and the collation of sufficient information to evaluate the cause and effect of all proposed actions.

India has been a very active participant in international climate change fora. India made its initial communication on climate change impact assessment, vulnerability to UNFCCC through the project known as NATCOM (National Communication) in 2004. This and subsequent NATCOM area specific reports remain the only significant national-level assessment of the impacts of climate change on water resources (note that this is in a country where water demand is predicted to exceed supply in 2050, without taking into account climate change effects).

The Fourth IPCC Assessment report (2007) predicts severe stress on the already stressed ecosystems of India – ranging from increased drought and river system closure to reduced flows in Himalayan river systems to extreme precipitation events to changes in crop yields and reduced ecosystem resilience. India has experienced a series of natural climatic events which fall outside the usual natural variability and are associated with climate change. Whilst these events have had severe impacts on people living in the affected areas, some people maintain that they are isolated freak events – whilst others attribute them to climate change (however the proportion of the latter is increasing with time and evidence).

Recent developments in collaborative research with UK institutions and others indicate increasing interest and concern amongst policymakers and researchers in India. There is limited awareness about freshwater ecosystem services in India – religious and value-based beliefs prevail, even though some of them are based on hydrological 'myths'. Other parties and drivers that affect water ecosystem services – such as afforestation targets, biofuel development and free extraction of groundwater – are not addressed coherently, and not in the context of climate change.

Suggested research priorities include research to support policy improvement, and in particular implementation, evaluation, linkages between policies and consideration of the effects on ecosystems. Research organisations and networks may be best placed to take the initiative on these issues, and in particular to communicate research information to policymakers in appropriate ways. Research priorities also include support for governance, particularly addressing the mismatch between hydrological and administrative boundaries. Research infrastructure should include a framework for integration, planning, monitoring and assessment. Within this, a series of components are suggested for addressing technical, environmental and social issues as well as support in negotiation and community participation.

ACRONYMS

CAPART	Council for Advancement of People's Action and Rural Technology
CRES	Centre for Natural Resources Management
CWC	Central Water Commission
DAC	Department of Agriculture and Cooperation
DARE	Department of Agricultural Research and Education
DDP	Desert Development Programme
DFID	Department for International Development
DPAP	Drought Prone Areas Programme
DST	Department for Science and Technology
EAPs	Externally Aided Projects
EAS	Employment Assurance Scheme
EP	Environment Policy
FAWPIO	Forest, Land and Water Policy – Improving Outcomes
FRP	Forest Research Programme
FPR	Soil and Water Conservation in the Catchments of Flood Prone Rivers
GHG	Green House Gases
GoI	Government of India
IAEPS	Integrated Afforestation and Eco-development Projects Scheme
ICAR	Indian Council for Agricultural Research
IIT	Indian Institute of Technology, Delhi
IPCC	Intergovernmental Panel for Climate Change
ISWD	Interstate Water Disputes
IWDP	Integrated Wasteland Development Programme
IPS	Investment Promotional Scheme
JFM	Joint Forest Management
KAWAD	Karnataka Watershed Development Society
MANAGE	National Institute for Agricultural Development and Management
MDGs	Millennium Development Goals
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forests
MoRD	Ministry of Rural Development
MoWR	Ministry of Water Resources
NATCOM	National Communication to the UNFCCC
NCIWRD	National Commission for Integrated Water Resources Development
NIRD	National Institute of Rural Development
NLCB	National Land Use and Conservation Board
NRDMS	National Resources and Data Management System
NWDPRA	National Watershed Development Programme for Rainfed Areas
NWP	National Water Policy
NWPD	National Wasteland Development Board
NWRC	National Water Resources Council
RVP	Soil and Water Conservation in the Catchments of River Valley Projects
SEZ	Special Economic Zone
SLUB	State Land Use Boards
SPM	Summary for Policy Makers
TDET	Technology, Development, Extension and Training
UNFCCC	United Nations Framework Convention for Climate Change
WDPSCA	Watershed Development Project in Shifting Cultivation Areas

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1. "Mapping" policies that affect the relationship between water ecosystem services and the poor

This report is part of a wider study entitled 'Water ecosystem services and poverty reduction under climate change', which is being coordinated by the International Institute for Environment and Development for DFID. The purpose of the wider study is to scope a possible DFID research programme – including key research areas and delivery mechanisms - on freshwater ecosystem services and poverty reduction, in the context of climate change and other drivers of change. This has involved an international consultation, literature review and policy and practice analyses in key developing countries.

This report presents the policy and practice analysis for India. It aims to understand how, and to what extent policy and planning related to water ecosystem services impact on practice in India.

The report is in five sections. Section 1 introduces the current water resources scenario and projected future demand; analyses the policies and legislation regarding water resources; and describes the various organisations concerned with water and the links between them. Section 2 introduces climate change to the equation, and presents the findings of both international and Indian assessment of the likely impacts on India's water resources. In the same section we reflect on the policy response within India. Section 3 considers policy instruments and programmes in terms of whether they will deliver intended impacts in the context of climate change. Section 4 considers other parties and drivers that influence policy concerning water ecosystem services and the implications of some of those forces. The final section presents research priorities in terms of policy improvement, support for governance, and support for research infrastructure.

1.1 The present Indian water resources scenario

In order to have a good understanding of the policy and practice of the water resources in India, an initial setting of the water resources may be helpful. India, with its geographical area of about 329 million hectare (mha) is covered by a large number of small and big rivers. A major part of India's population is rural and agriculturally oriented, for whom the rivers are the source of their prosperity (NCIWRD, 1999).

Climate plays a very decisive factor in water resource availability of a country. The climate ranges from continental to oceanic, from extremes of heat to extremes of cold, from extreme aridity and negligible rainfall to excessive humidity and torrential rainfall. Rainfall in India is mainly dependent on the southwest monsoon between June and September, and the northeast monsoon between October and November. The variations in temperature are also marked over the Indian sub-continent. During the winter season from November to February the temperature decreases from south to north due to the effect of continental winds over most of the country.

Evapotranspiration rates closely follow the climatic seasons, and reach their peak in the summer months of April and May. The central areas of the country display the highest evapotranspiration rates during this period. After the onset of monsoon potential evapotranspiration decreases generally all over the country. The freshwater ecosystem services offered relate very closely to the climatic settings of each of the biophysical systems.

India is blessed with many rivers. As many as twelve of them are classified as major rivers (having a catchment area of more than 10 mha), with a total catchment area of 252.8 mha. Of the major rivers, the Ganga-Brahmaputra-Meghana system is the biggest with catchment area of about 110 mha, which is more than 43 per cent of the catchment area of all the major rivers in the country (Table 1).

Table 1: Major river basins of India

Name of the river	*Length (Km.)*	*Catchment area (km^2)*	*Average annual potential in river (cu km)*	*Utilisable surface water (cu km)*
Indus	1,114 +	321,289 +	73.31	46.00
a) Ganga	2,525 +	861,452 +	525.02	250.00
b) Brahmaputra	916 +	194,413 +	629.05	24.00
c) Barak & other rivers flowing into Meghna, like Gomti, Muhari, Fenny etc.		41,723 +	48.36	
Sabarmati	371	21,674	3.81	1.93
Mahi	583	34,842	11.02	3.1
Narmada	1,312	98,796	45.64	34.50
Tapi	724	65,145	14.88	14.50
Brahmani	799	39,033	28.48	18.30
Mahanadi	851	141,589	66.88	49.99
Godavari	1,465	312,812	110.54	76.3
Krishna	1,401	258,948	69.81	58.00
Pennar	597	55,213	6.32	6.86
Cauvery	800	81,155	21.36	19.00
Subernarekha			12.37	6.81
West Flowing Rivers of Kutch, Saurashtra including Luni			15.10	14.98
West Flowing Rivers south of Tapi			200.94	36.21
East flowing rivers between Mahanadi and Godavari			17.08	13.11
East flowing rivers between Godavari and Krishna			1.81	
East flowing rivers between Krishna and Pennar			3.63	
East flowing rivers between Pennar and Cauvery			9.98	16.73
East flowing rivers south of Cauvery			6.48	
Rivers draining to Bangladesh			8.57	
Rivers draining to Myanmar			22.43	
Total			1,952.87	690.32

Source: Reassessment of Water Resources Potential of India – CWC, MOWR, Government of India.

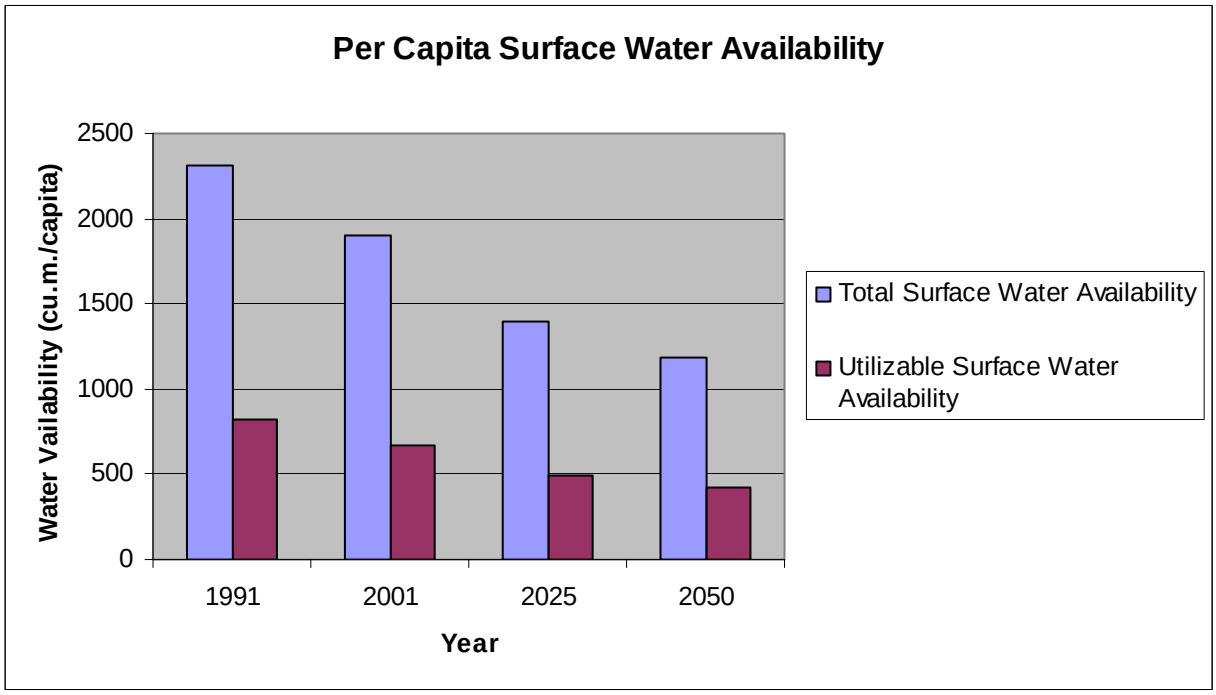
The other major rivers with catchment areas more than 10 mha are Indus (32.1 mha), Godavari (31.3 mha), Krishna (25.9 mha) and Mahanadi (14.2 mha). The total catchment area of medium rivers is about 25 mha and the Subernarekha, with 1.9 mha catchment area is the largest amongst the medium rivers in the country.

The annual precipitation, including snowfall, which is the main source of the water in the country is estimated to be of the order of 4,000 cu.km. There are 35 meteorological sub-divisions with respect to the rainfall variability. The water resources potential of the country is about 1,953 cu.km. (occurring as natural run off in the rivers) and an additional 396 cu.km. (occurring as groundwater), as per the latest basin wise estimates made by the Central Water Commission (Tables 1 and 2). The Ganga-Brahmaputra-Meghna system is the major contributor to the surface water resources

potential of the country. Its share is about 60 per cent in total water resources potential of the various rivers (NCIWRD, 1999).

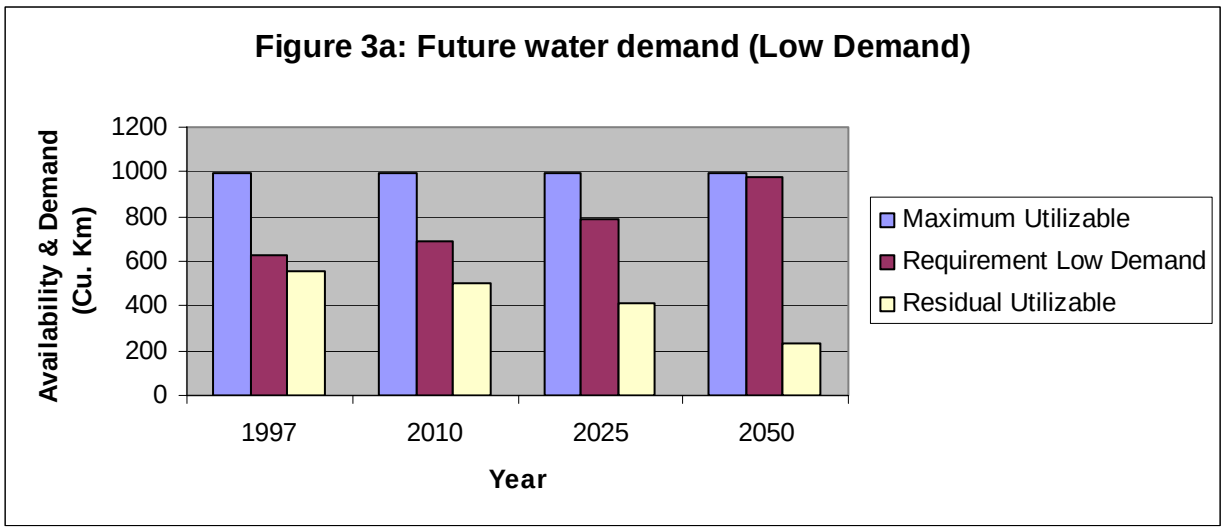
Due to various constraints of topography, uneven distribution of resources over space and time, it has been estimated that only about 690 cu.km. of surface water resources potential can be put to beneficial use (Table 1). Again about 40 per cent of utilisable surface water resources are presently in Ganga-Brahmaputra-Meghna system. In the majority of river basins, present utilisation is significantly high and is in the range of 50 per cent to 95 per cent of utilisable surface resources. The per capita surface water availability in India on the basis of census of 1991 and 2001 works out to be 2,309 and 1,902 cu.m and these are projected to be 1,401 and 1,191 cu.m for the years 2025 and 2050 respectively, merely on the basis of population projections and with the assumption that the availability of water resources shall not change in future (Figure 2).

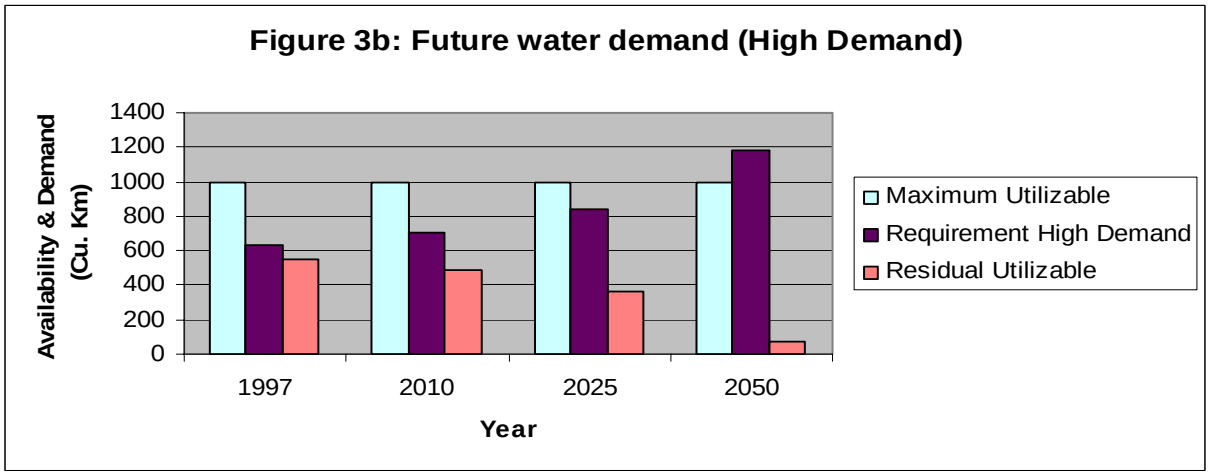
Figure 2: Present and projected per capita surface water availability



Groundwater is another major component of the total available water resources in India. Groundwater utilisation has been increasing over the past three decades and is likely to increase in the coming years. This trend can potentially change the existing environmental services of surface and groundwater resources. Although groundwater is an annually replenishable resource, its availability is non-uniform in space and time. Based on the norms given by the Ground Water Over Exploitation Committee, the State Governments and the Central Ground Water Board computed the gross groundwater recharge as 432 cu. Km., against the figure of 396 cu.km. projected using the previous methodology (NCIWRD, 1999).

The last estimates made by the Ministry of Water Resources with respect to the water requirements (NCIWRD, 1999) for various uses have been estimated for the present and the future years for high and low demands, corresponding to low and high growth rates (Table 2). The water demand has been discounted for return flow, which is the irrigation water that goes back into the river system or the groundwater after being spread on the ground surface (Figures 3a and 3b).





The Ministry of Water Resources has concluded that the water availability shall be in a position to meet requirements till the year 2050 through integrated water management plans. The issue of demand management has been given due importance to achieve a higher level of water use efficiencies. The Ministry of Water Resources has presented a very rosy picture by declaring that there is nothing to worry about at least till 2050 if we enhance water use efficiencies and indulge in demand management. It is important to note that two very crucial factors have been ignored in making these computations. Firstly the impact of programmes such as watershed management on the water resources has been ignored completely, maybe assuming that it shall have an insignificant impact. Secondly, the analysis does not take into account any possible impact due to climate change while making the future projections. The picture might completely change if these two factors are taken into consideration. Furthermore, there has been no attempt to enumerate the ecosystem services being provided by these freshwater systems. The possible reason behind such a drawback is that these assessments have been made by conventional water resources engineers, who have always indulged in the process of water resources development without bothering much about ecosystem services rendered by the system. It may also be mentioned that the National Water Policy makes a large number of recommendations that can circumvent many of the problems being faced by the country.

Table 2: Utilisable water, requirement and return flow based on national average (in km^3)

Particulars	1997-1998	Year 2010		Year 2025		Year 2050	
		Low Demand	High Demand	Low Demand	High Demand	Low Demand	High Demand
Utilisable water							
Surface	690	690	690	690	690	690	690
Ground	396	396	396	396	396	396	396
Canal Irrigation	90	90	90	90	90	90	90
Total	996	996	996	996	996	996	996
Total Water requirement							
Surface	399	447	458	497	545	641	752
Ground	230	247	252	287	298	332	428
Total	629	694	710	784	843	973	1180
Return Flow							
Surface	43	52	52	70	74	91	104
Ground	143	144	148	127	141	122	155
Total	186	196	200	197	215	213	259
Residual Utilisable Water							
Surface	334	295	284	263	219	140	42
Ground	219	203	202	146	149	96	33
Total	553	498	486	409	368	236	75

Source: NCIWRD (1999)

1.2 Water in the Indian Constitution

In India, water is a State subject, as opposed to a Union or concurrent subject. The constitutional provisions are described in Box 1. From the very beginning, after Independence, water resources development through major and medium projects has been the thrust for developing India's irrigation and hydropower potential. Therefore, the majority of policies and planning even till date revolve around these water resources development projects.

Box 1: Water in the Indian Constitution

Responsibilities between the State and Centre as per the constitutional provisions are categorised into: The Union List (List-I), the State List (List-II) and the Concurrent List (List-III). Article 246 of the Constitution[1] deals with subject matter of laws to be made by the Parliament and by Legislature of the States. Water has been included in the Constitution in Entry 17 of List-II i.e. State List. This entry is subject to the provision of Entry 56 of List-I i.e. Union List. The specific provisions under Article 246 are as under:

1) Parliament has exclusive power to make laws with respect to any of the matters enumerated in List I referred to as the "Union List".

2) Parliament, and, the legislature of any State also, have power to make laws with respect to any of the matters enumerated in List III in the Seventh Schedule referred to as the "Concurrent List".

3) The Legislature of any State has exclusive power to make laws with respect to any of the matters enumerated in List II in the Seventh Schedule referred to as the "State List".

In case of disputes relating to waters, Article 262[1] provides:

1) Parliament may by law provide for the adjudication of any dispute or complaint with respect to the use, distribution or control of the waters of, or in, any inter-State river or river valley.

2) Parliament may by law provide that neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any such dispute or complaint as is referred to in Clause (1).

In spite of the fact that water is a State subject, the Centre plays an advisory role in formulating policies and helping in the planning and development process. In addition, the Centre considers inter-state issues.

In 1956, two acts relating to interstate rivers were passed. These were the Interstate Water Disputes (ISWD) Act[2] and the River Boards Act[3]. While presenting the River Boards Bill before the Rajya Sabha, the then Union Minister of Irrigation and Power stated that the River Boards Act would be used for the management of interstate rivers in the country, whereas the ISWD Act was to be used only in certain special cases where the River Boards Act could not be used (Article-8, ISWD Act). However what has been seen in all these years is that ISWD Act has been used for most of the interstate rivers while there has been no river board set up under the River Boards Act till date. This is highly unfortunate as:

- the ISWD Act had a narrow purpose of adjudicating the disputes that arise between States in the future and hence was an outcome of the judicial function of the government. On the other hand the River Boards Act was based on the welfare and developmental function of the government and had a wider purpose of providing for the overall growth and development of the interstate rivers.
- The River Boards Act provides for arbitration to resolve the disputes whereas the ISWD act provides for adjudication. In case of adjudication lawyers have to be engaged and hence it becomes a long drawn out and costly process.
- River Boards were designed to be permanent bodies whereas the Tribunals set up under ISWD Act are temporary bodies which cease to exist after the award is given and all clarifications addressed.

The inability of the Government to implement the River Boards Act has resulted in ill planned and mismanaged water resources with no concern given to many of the ecosystem services.

1.3 Institutions involved with water issues

The National Water Resources Council (NWRC) is the apex policy making body for water resources development in India. It is only an advisory body to the Government of India. It was entrusted with the formulation of the National Water Policy in 1987, that was subsequently improved and updated in 2002. These policies were placed before parliament and then circulated to the central ministries and states for implementation. Progress in implementation of the Acts is reviewed by the National Water Board, constituted solely for this purpose. Water is a state subject

[1] http://wrmin.nic.in/index.asp
[2] http://wrmin.nic.in/cooperation/default9.htm
[3] http://wrmin.nic.in/constitution/default2.htm

and the administrative control and responsibility for water development rests with the various State Departments and Corporations. The Ministry of Water Resources is mainly responsible for the development of the major water resources projects along with a large number of other ministries. Its relationship with the NWRC and other major ministries and organisations is shown in Figure 1 (Amezaga *et al*, 2003).

1.4 The National Water Policy

The National Water Policy was adopted in September 1987 and was reviewed and updated in April 2002. The National Water Policy provides for some of the amendments needed in the ISWD Act (Article-21.2). Some of the features of the new National Water Policy (NWP, 2002) are:

1) The National Water Policy provides for the formulation of the River Basin organisations, it states also that the "scope and powers of the river basin organisations shall be decided by the basin states themselves" (Article 4.2). In the case of interstate rivers, such a move has never been made because of the mistrust and also due to the absence of a facilitator. This role may have to be entrusted to the Union government, if we want to manage the interstate rivers in the best possible manner.

2) It provides for the creation of a standardised national information system promoting free exchange of data among various agencies (Articles 2.1 and 2.2). Here it might be mentioned that as per the Sarkaria commission recommendations[4], a data bank and information system at the national level has to be set up at the earliest and the states shall be required to compulsorily make the necessary data available. However the ground realities show that data accessibility is the major constraint for individual researchers as well as organisations, which leads them to take case studies of international water bodies at the cost of providing solutions using state of the art technologies for the Indian systems.

3) It provides for "adequate safe drinking water facilities" without mentioning the quantity of water in lpcd which should be provided at the urban and rural levels for various densities of population (Article 8). Although there is no mention of the quality of drinking water, Article 14 recommends regular water quality monitoring of surface and groundwater against the national water quality standards.

4) Article 27 states that "State Water Policies backed with operational action plans shall be formulated in 2 years". Some of the States such as Madhya Pradesh, Himachal Pradesh, etc., have come up with draft Water Policies but are not much different from the National Water Policy in terms of their implementation.

5) The National Water Policy also recognises that water resource development should be planned for in hydrological units, or watersheds.

The National Commission for Integrated Water Resources Development Plan had recommended repealing the River Boards Act and enacting a new Act called the Integrated and Participatory Management Act. It is proposed that sustainability in the quantity and quality of water resources can be achieved by taking into account multi-sectoral factors such as groundwater, surface water and other environmental considerations. Although the Act has not been passed as recommended, it has been reflected in the Environment Policy (EP, 2006). The EP also addresses many other issues such as climate change and its impact on various sectors and the importance of exploring coping strategies.

[4] http://wrmin.nic.in/cooperation/default9.htm

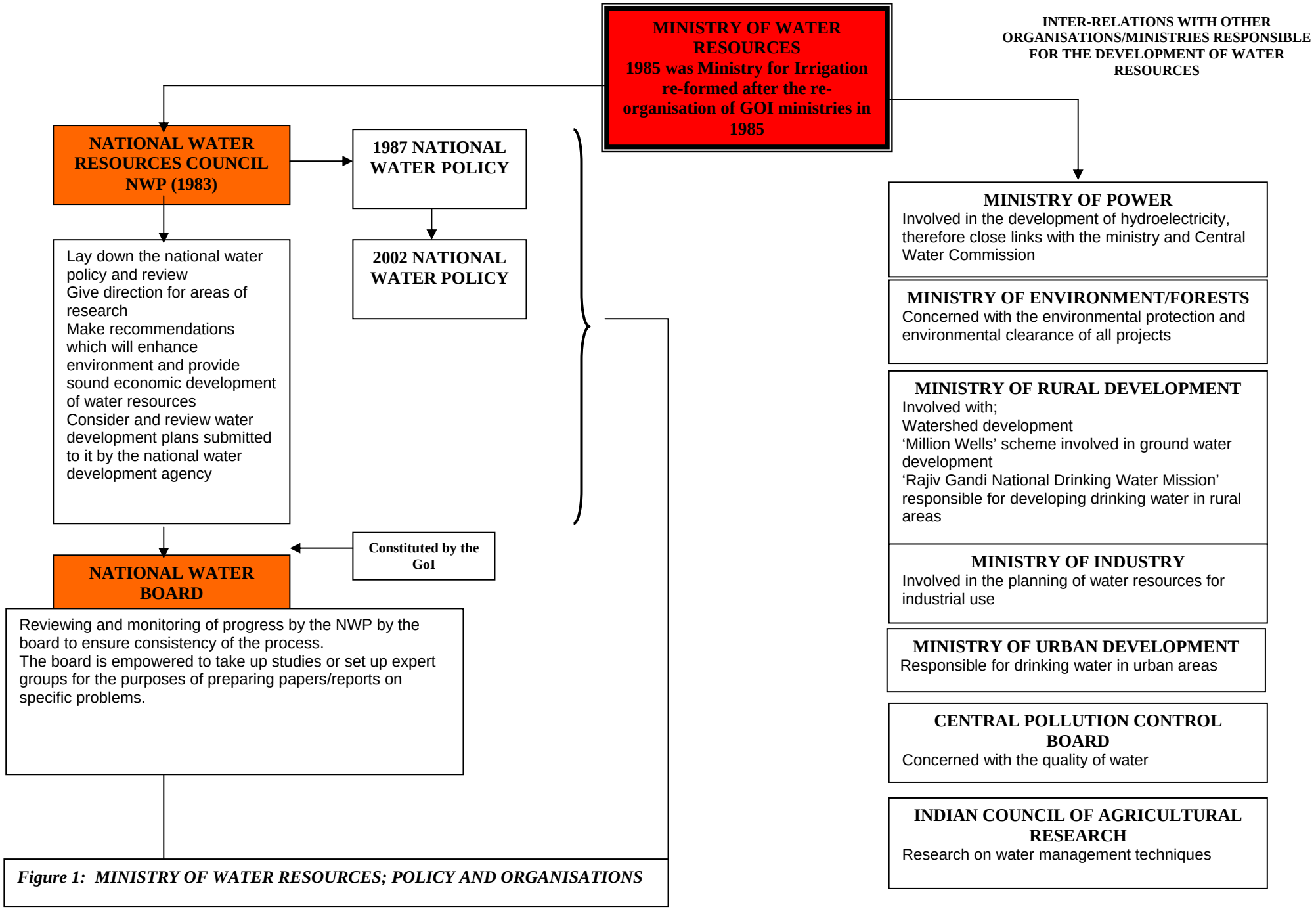


Figure 1: MINISTRY OF WATER RESOURCES; POLICY AND ORGANISATIONS

1.5 Water, land and forest management at local level

In India, a very large extent of development in land and water resources is also taking place through a parallel mechanism and at the scale of very small areas in the form of watershed management. Although considered to be a benign development, it has been proved to have far reaching consequences if not handled properly.

1.5.1 Institutions involved with land and water issues at local level

Whilst there is no national legislation for land policy, land is also regarded as a state subject. Formally, guidelines for planning and management of land resources should be discussed between the State Land Use Boards (SLUB), the National Land Use and Conservation Board (NLCB) and the National Wasteland and Development Board (NWDP). However, it is recognised that there is a pressing need to revitalize these organisations to serve their original purpose of promoting integrated land use planning (GOI Planning Commission, 2001). Land policy is also indirectly and subtly conveyed through other policies such as the National Water Policy 2002, Environment Policy and the Watershed Programmes. There are currently no national policies in place which broach water demand management through any of the institutions.

Watershed development in India has been managed by three central ministries: the Ministry of Agriculture (MoA), the Ministry of Rural Development (MoRD) and the Ministry of Environment and Forests (MoEF) (Panchayati Raj and Natural Resources Management, 2000). The Planning Commission of India, which is in charge of the development of Five-Year Plans for the effective and balanced utilisation of the country's resources, co-ordinates long-term policy development in this area. The Commission is separated into Divisions which establish sector-wise Working Groups to make recommendations on policy matters for the formulation of the Five-Year Plan. Watershed development is in the Agriculture Division. There is also a Water Resources Division and an Environment and Forestry Division.

Indian planning now has an emphasis on decentralised local planning. After the 1993 reform below the State level there are now District Panchayats, Block Panchayats and Village Panchayats. The most significant development is that the Panchayats have been assigned a wide range of functions with respect to the preparation of plans and implementation of schemes for economic development and social justice. Some of these functions include agriculture, land improvement and soil conservation, minor irrigation and water management, social forestry and farm forestry. The role of the Panchayats in watershed development has been enhanced with the recommendations of the Haryali Guidelines of the watershed development (Guidelines for Hariyali, 2003) and they have been recognized as the primary implementing agency of watershed planning and action. In principle there are committees such as the Watershed Committee, which are supposed to have technical members responsible for providing technical help in their domains. However, in actual practice such expertise is very rarely available in the rural areas, with the result that interventions are being made without any sound planning.

The Department of Science and Technology (DST) of the Ministry of Science and Technology and the Ministry of Information Technology provide science and technology inputs to the different ministries involved in land and water management. In particular, the Natural Resource Data Management Systems (NRDMS) programme of the DST is working to develop methodologies and technological tools to enable local bodies to prepare and implement plans. The outputs of this R&D programme should contribute to the capacity building of the national watershed management programmes and make a contribution in formulating national policy for watershed management (DST, 2002). However, this is a slow process and requires capacity building at the local and the next higher levels.

1.5.2 Watershed development programmes

The MoA, MoRD and the MoEF, along with their respective line departments in the Indian states, are the three main government ministries in charge of watershed protection and development. Each programme focuses on different aspects and activities within the ministries' watershed development criteria (Figure 4).

The MoA has worked in watershed development since the 1960s and deals with issues including erosion prone agricultural lands, optimizing production in rainfed areas and reclaiming degraded lands. The Department of Agriculture and Cooperation (DAC) and the Department of Agricultural Research and Education (DARE) of MoA are involved in all aspects of watershed development. They are supported by two autonomous bodies; the Indian Council for Agricultural Research (ICAR), and the National Institute for Agricultural Extension and Management (MANAGE). The MoA is currently implementing several schemes/ programmes including the National Watershed Development Project for Rainfed Areas (NWDPRA), Soil and Water Conservation in the Catchments of River Valley Projects (RVP) and Flood Prone Rivers (FRP), Reclamation of Alkali Soils, Watershed Development Project in Shifting Cultivation Areas (WDPSCA) and Externally Aided Projects (EAPs).

The MoA puts 156 mha (about 49 per cent of the total geographical area) as the cultivated acreage. This is bifurcated into 53 mha irrigated, 90 mha rainfed and 14 mha of fallow area. The forest area is estimated to be 68 mha (22 per cent). A recent estimate further puts the degraded land at 174 mha (53 per cent) of the 329 mha of the geographical area. The majority of this area (107 mha) is degraded on account of water erosion, whereas the contribution of other factors to land degradation include: wind erosion 17.79 mha, degraded forests 19.49 mha, water logging 8.52 mha, shifting cultivation 4.91 mha, and salt affected areas 3.97 mha (Sharma, 2002). The degraded area is composed partly of cultivated land and partly of forest land.

The MoRD has been implementing watershed projects only since the late 1980s. It deals with non-forest wastelands and poverty alleviation programmes with important components of soil and water conservation. The key department in MoRD is the Department of Land Resources (in particular the Wastelands Development Division). However there are two other departments, the Department of Drinking Water Supply and Department of Rural Development also involved in watershed development activities.

Two organisations support the MoRD: the National Institute of Rural Development (NIRD) and the Council for Advancement of People's Action and Rural Technology (CAPART). The former provides advice on policy matters about watersheds, through the Centre for Natural Resources Management (CRES), whilst CAPART deals with the voluntary sector. CAPART also has a division which sanctions watershed projects to NGOs and voluntary organisations. Programmes implemented by MoRD include the Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP), Integrated Wastelands Development Programme (IWDP), ongoing watershed projects under the Employment Assurance Scheme (EAS), Technology, Development, Extension and Training (TDET), Investment Promotional Scheme (IPS), Support to NGOs, the small Wastelands Development Task Force Scheme in MP and some Externally Aided Projects (EAPs).

The MoEF is one of the ministries dealing with forest and wasteland issues. Since 1989 the ministry implemented the Integrated Afforestation and Eco-development Projects Scheme (IAEPS) with the intention of promoting afforestation and the development of degraded forests within an integrated watershed approach.

Until 1995, watershed development projects were officially co-ordinated by multi-sectoral programmes (with differing objectives) launched by the GoI. After review in 1999 by the MoRD and the MoA a common set of operational guidelines, objectives, strategies and expenditure norms were established for watershed development programmes in 2001. These are implemented through programmes such as DPAP, DDP and IWDP (overseen by the Department of Land Resources). The guidelines encourage the active involvement of non-governmental organisations, semi-governmental institutions and private enterprises, universities and training institutions. Whilst these programmes have laudable objectives there remains the concern that the emphasis of many watershed development programmes is still firmly based on the belief that water resources remain unexploited and are still available for development through both groundwater abstraction and through the use of water harvesting techniques (Gosain *et al*, 2007).

The MoRD has revised these guidelines through a recent initiative called "Hariyalli" (MoRD, 2004), which literally means greenery, and has the following objectives for projects taken under the scheme:

i. *Harvesting every drop of rainwater for purposes of irrigation, plantations including horticulture and floriculture, pasture development, fisheries etc. to create sustainable sources of income for the village community as well as for drinking water supplies.*
ii. *Ensuring overall development of rural areas through the Gram Panchayats and creating regular sources of income for the Panchayats from rainwater harvesting and management.*
iii. *Employment generation, poverty alleviation, community empowerment and development of human and other economic resources of the rural areas.*
iv. *Mitigating the adverse effects of extreme climatic conditions such as drought and desertification on crops, human and livestock population for the overall improvement of rural areas.*
v. *Restoring ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover especially plantations.*
vi. *Encouraging village community towards sustained community action for the operation and maintenance of assets created and further development of the potential of the natural resources in the watershed.*
vii. *Promoting use of simple, easy and affordable technological solutions and institutional arrangements that make use of, and build upon, local technical knowledge and available materials.*

All the objectives except the first one, where the intention is to harvest every drop of water, are very legitimate and can be pursued effectively provided an elaborate mechanism to implement such objectives is put in position. However, if one goes through the complete set of recommendations it may be realized that all the recommendations are mainly geared towards ensuring proper utilization of funds having fixed a rate of development *apriori* (Rs 6,000 per hectare or so). It may be debated that it is only a mechanism of arriving at a figure which can be taken as the maximum cap, but there will be hardly any project where less than this figure is disbursed. This is one single reason that most of the watershed projects have landed up with interventions that can consume maximum funds irrespective of the facts whether they are justified or not.

As far as the first objective is concerned, the intent to harvest every drop which falls over the area might be dangerous from an ecological and environmental angle. It has the capability of bringing about biophysical changes to the extent that the total character of the existing hydrological regime is changed. There might not be any surface flow available any more to the downstream areas (Gosain and Calder, 2003). It must be understood that every area has a prevalent water balance and any intervention caused is bound to change its water balance, the extent of which is dictated by many factors including the local biophysical characteristics and

weather conditions. It is unfortunate that the emphasis in watershed development programmes is still firmly based on the belief that water is essentially an infinite resource and can be managed through the continual development of groundwater abstraction together with the implementation of water harvesting techniques (KAWAD, 2001).

The present implementation of the watershed management programmes in India including the latest 'Hariyalli' programme has many shortcomings. Some of the major ones include:

- invariably ignoring the hydrological boundaries of the watersheds
- ignoring the connectivity of the watersheds and treating each watershed as a stand alone unit, where activities within the watershed are considered independent of their impacts downstream
- ignoring the hydrological characteristics of the watershed while deciding on the possible interventions
- non-availability of the quantitative evaluation procedures, and
- ignoring the environmental sustainability aspects.

Legislation promoting central and state adaptation of the programmes and the involvement of outside parties and autonomous agencies has led to a myriad of watershed development programmes and research initiatives at the state and district level. Looseness in departmental co-ordination is again reflected at the national level by the Working Group of the Planning Commission. The Group has recommended a 25-year Perspective Plan on sustainable rainfed agriculture through Watershed Development to treat/ reclaim/ cover 63.40 mha of land by the end of XIII Plan (Table 3) at a cost of Rs. 758,000 million (Sharma, 2002). The Perspective Plan presupposes that each of these ministries has a definite niche area based upon their role in past watershed programmes. The recommendation of a mechanism to avoid the overlap in the activities of the three major ministries MoRD, MoA and MoEF through compartmentalising functions has further increased the divisions within watershed management.

Table 3: 25-Year Perspective Plan for Sustainable Rainfed Agriculture through Watershed Development

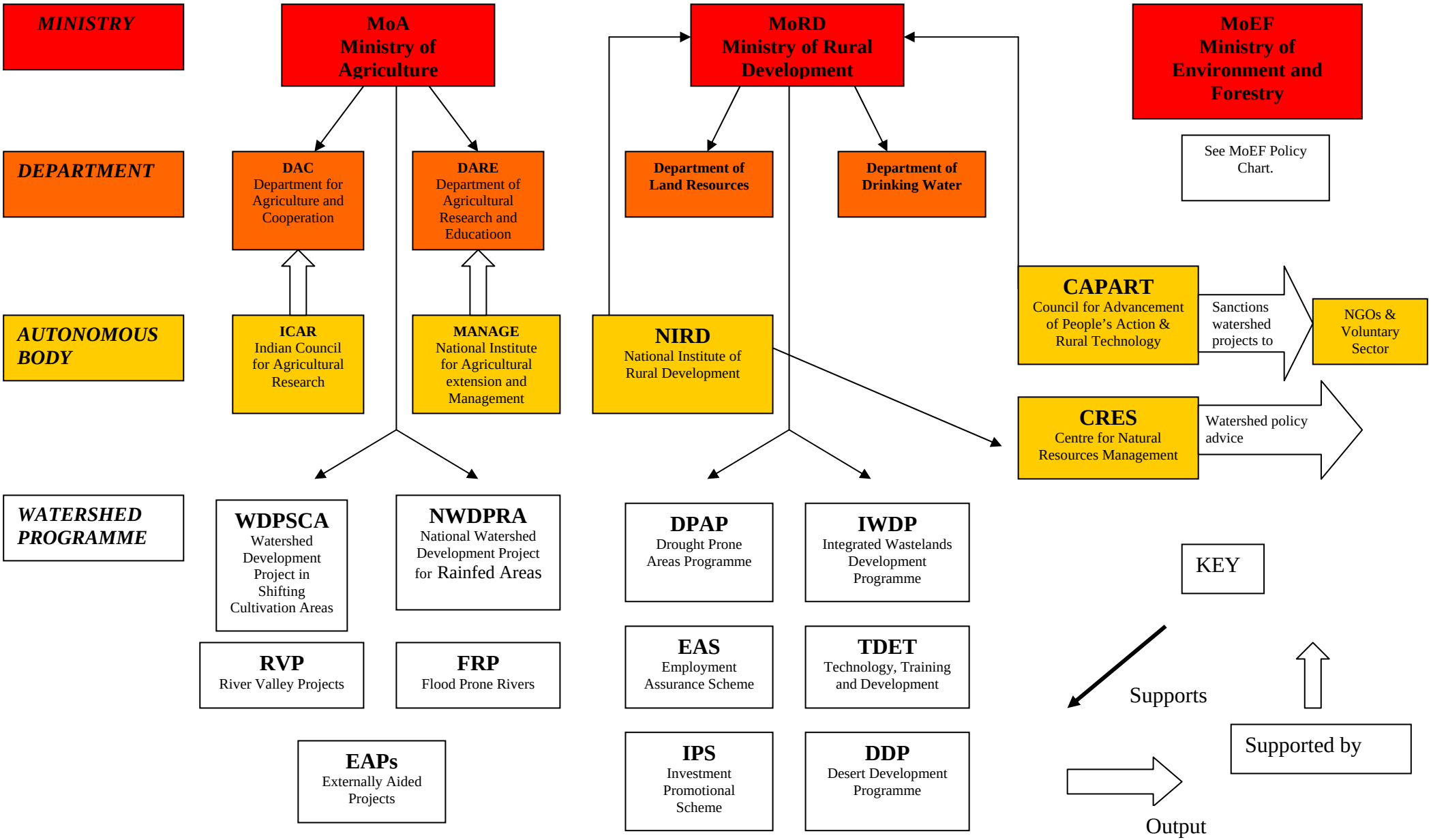
Plan period	*Area proposed for treatment (million ha)*	*Per ha cost (Rs.)*	*Total cost of treatment (million Rs.)*
IX Plan (1997-2002)	10.00	5,000	50,000
X Plan (2002-2007)	12.00	7,500	90,000
XI Plan (2007-2012)	15.00	11,000	165,000
XII Plan (2012-2017)	15.00	15,000	225,000
XIII Plan (2017-2022)	11.40	20,000	228,000
Total	63.40		758,000

Source: Sharma (2002)

The difficulties in disseminating knowledge, experience, scientifically validated information and methodologies are made worse by the lack of any common framework between states and departments. This is accentuated further by the lack of any common set of agreed management strategies based upon validated scientific knowledge.

The MoEF is expected to take control of forested areas, whereas the MoRD is meant to keep control of the schemes such as DPAP, DDP, IWDP previously started by the ministries. Similarly, it is a Government of India recommendation that the MoA should concentrate on watersheds containing ‘panchayats’ (village councils) through schemes like NWDPRA. This approach of compartmentalizing the functioning of the different ministry players is the exact opposite to the integrated approach that the country claims to follow.

Figure 4: INDIAN MINISTRIES INVOLVED IN WATERSHED DEVELOPMENT
(Adopted from Amezaga et. al., 2003)

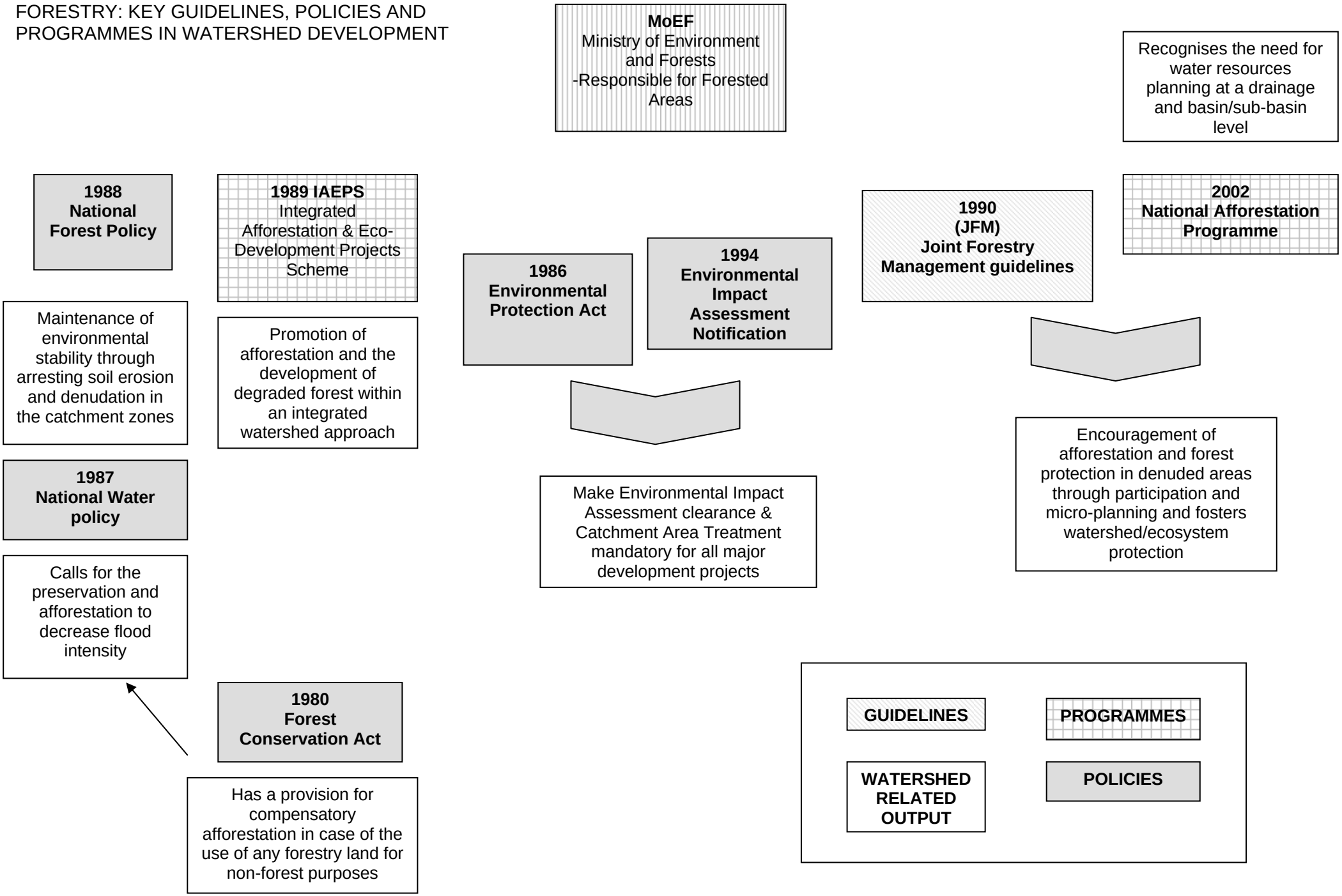


1.5.3 Where is the "integration"?

Integrated watershed management does not merely imply the amalgamation of different activities to be undertaken within a hydrological unit. It also requires the collation of relevant information so as to evaluate the cause and effect of all the proposed actions. The watershed is the smallest unit where the evaluation of man-induced impacts upon natural resources becomes possible with respect to the water balance approach. Therefore although the 'panchayat' remains the preferred implementation unit, the watershed should be the evaluation unit used in assessing impacts. The evaluation process does not need to be complicated, a simple audit can also suffice the requirement.

As the impacts resulting from actions taken at the 'panchayat/ watershed' level will be experienced at a higher level within the drainage basin, the assessment of these impacts will require the availability of a framework which enables the mapping of such units and their entities and the interconnections from the Panchayat level to the higher catchment level in the hierarchy of River Basin at the highest level of drainage system to catchment at the intermediate level and the watershed at the lowest level. Such a framework will need regular maintenance and updating to reflect fully the most accurate ground-truthed data or the infrastructure requirements for planning and management of the natural resources collected by the relevant departments. This framework, once available, could be used by all the line departments and updated by the relevant departments which have designated areas of jurisdiction over the data entry. The format should be made consistent with local to state and national level structures as well as the corresponding watershed, catchment and basin level structures. Such a framework shall also be used to enumerate the freshwater ecosystem services each system is serving.

Figure 5: MINISTRY OF ENVIRONMENT AND FORESTRY: KEY GUIDELINES, POLICIES AND PROGRAMMES IN WATERSHED DEVELOPMENT



2. "Overlay" of the policy map with climate change

Climate change will affect the water balance, and particularly the amount of runoff and recharge, which in turn determines the water resources available for human and ecosystem uses. Some parts of the world will experience a reduction in resource availability, while others will see an increase.

The Comprehensive Assessment of the Freshwater Resources of the World estimated in 1997 that approximately one third of the world's population lives in countries experiencing moderate to high water stress, and forecast that by 2025 as much as two thirds of a much larger world population could be under stress conditions simply due to the rise in population.

With respect to the global climate change scenarios, the impact on water resources has been summarised[1] as below:

- With unmitigated emissions, by the 2080s, there are large changes predicted in the availability of water from rivers. Substantial decreases are seen in Australia, India, southern Africa, most of South America and Europe, and the Middle East. Increases are seen across North America, Asia (particularly central Asia) and central eastern Africa.
- An emissions scenario leading to stabilisation of CO_2 at 750 ppm generally slows down the rate of change in river flows, compared to an unmitigated emissions scenario, by about 100 years (more in Asia, slightly less in Europe). Stabilisation at 550 ppm delays the change still further, particularly in South America and Asia.
- With unmitigated emissions, water resource stress due to climate change by the 2080s is predicted to worsen in many countries (for example, northern Africa, the Middle East and the Indian subcontinent) but improve in others (for example China and the USA). Emissions leading to stabilisation at 550 ppm will reduce the number of people affected by water stress due to climate change from about three billion to about one billion.

The first effort in recognising the importance of taking the subject of climate change seriously in India started with the taking up of the India's Initial National Communication to the United Nations Framework Convention on Climate Change in 2000 (NATCOM, 2004). A large number of research groups were involved in taking up studies related to a large number of areas with respect to the aspects of mitigation, vulnerability assessment and adaptation to climate change. It is a very comprehensive study that shall lay the foundation for tackling the problem in India in an integrated manner. Having made the Initial Communication successfully in 2004, the Ministry of Environment and Forests has initiated the Second Phase of the National Communication study in May 2007. India has also been a very active participant to the international initiatives of COP, IPCC and UNFCCC. Some of the key inferences reflected on India in the Fourth Assessment Report of IPCC that shall have relevance to the freshwater ecosystem services are presented below.

2.1 Findings of the Fourth Assessment Report

The impact of climate change on the major sectors and on the region of Asia have been predicted (Box 2) in the Fourth Assessment Report of the IPCC (SPM, 2007) made public in April 2007 in Brussels. Some of the key predictions and their implications on freshwater ecosystems are described below.

It has been predicted with high confidence that the drought-affected areas will likely increase creating more stress on already stressed ecosystems of India. Such a situation, in conjunction with manmade interventions, can cause a situation of river system closure. Such a situation shall arise due to the tendency of utilising/ exploiting every bit of the available flow without bothering for any environmental flow left in the river system other than present surplus flow. Any reduction in future

[1] Available at: www.met-office.gov.uk/research/hadleycentre/pubs/brochures/imp_water_res.html

flow shall be taken from this available surplus and shall thus encroach upon the environmental flows.

There are also some areas predicted to experience extreme precipitation events, with increased frequency and intensity, thus causing enhanced flood risk. In India, the northeastern systems of Mahanadi and Baitarni rivers are expected to come under this category. Increase of frequency and severity of floods and droughts will have implications on the functioning of the ecosystems.

Water volumes stored in glaciers and snow cover are very likely to decline, reducing summer and autumn flows in the Himalayan river systems in the long run. This shall be a major impact on the breadbasket of India since the Himalayan glaciers feed many major systems of India. There shall be a large number of implications such as glacier lake bursts, structural safety of the existing structures, etc.

The climate change impacts are expected to influence the resilience of many ecosystems due to climate related disturbances such as wildfire, insects etc.

In the second half of this century terrestrial ecosystems are likely to become a net source of carbon, especially from previously under-estimated carbon stocks, thus amplifying climate change. With the global average temperature rising by 1.5-2.5°C, about 20-30 per cent of species are likely to be at high risk of irreversible extinction. Consequently, there are very likely to be major changes in ecosystem structure and function, species' ecological interactions, and species' geographic ranges, with predominantly negative consequences for goods and services.

At lower latitudes, especially the seasonally dry tropics, crop yield potential is likely to decrease for even small global temperature increases, which would increase the risk of hunger. This implies that most of the southern systems shall be highly affected and there would not be any respite for the farming communities of south India.

In addition, the coasts of India are very likely to be exposed to increasing risks due to sea-level rise and the effect will be exacerbated by increasing human-induced pressures on coastal areas.

Box 2: Some relevant findings of the Fourth Assessment Report of IPCC

Water

- Runoff and water availability are very likely to increase at higher latitudes and in some wet tropics, including populous areas in East and Southeast Asia, and decrease over much of the mid-latitudes and dry tropics, which are presently water-stressed areas. (High confidence)

- Drought-affected areas will likely increase and extreme precipitation events, which are likely to increase in frequency and intensity, will augment flood risk. Increase of frequency and severity of floods and droughts will have implications on sustainable development. (High confidence)

- Water volumes stored in glaciers and snow cover are very likely to decline, reducing summer and autumn flows in regions where more than one sixth of the world population currently live (High confidence)

Ecosystems

- The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. wildfire, insects), and other global change drivers (High confidence)

- In the second half of this century terrestrial ecosystems are likely to become a net source of carbon, especially from previously under-estimated carbon stocks, thus amplifying climate change (High confidence)

- Roughly 20-30 per cent of species are likely to be at high risk of irreversible extinction if global

average temperature exceeds 1.5-2.5°C (Medium confidence)

- For increases in global average temperature exceeding 1.5-2.5°C and in concomitant atmospheric CO_2 concentrations, there are very likely to be major changes in ecosystem structure and function, species' ecological interactions, and species' geographic ranges, with predominantly negative consequences for goods and services (High confidence)

Food

- Crop yield potential is likely to increase at higher latitudes for global average temperature increases of up to 1-3°C depending on the crop, and then decrease beyond that (allowing for effects of CO_2 fertilisation) (Medium confidence)

- At lower latitudes, especially the seasonally dry tropics, crop yield potential is likely to decrease for even small global temperature increases, which would increase risk of hunger (Medium confidence)

- Increased frequency of droughts and floods would affect local production negatively, especially in subsistence sectors at low latitudes (High confidence)

Coastal systems and low-lying areas

- Coasts are very likely to be exposed to increasing risks due to climate change and sea-level rise and the effect will be exacerbated by increasing human-induced pressures on coastal areas (Very high confidence)

- It is likely that corals will experience a major decline due to increased bleaching and mortality due to rising seawater temperatures. Salt marshes and mangroves will be negatively affected by sea-level rise (Very high confidence)

- Hundreds of millions of people are vulnerable to flooding due to sea-level rise, especially in densely populated and low-lying settlements where adaptive capacity is relatively low and which already face other challenges such as tropical storms or local coastal subsidence. The numbers affected will be largest in the mega-deltas of Asia but small islands face the highest relative increase in risk. (Very high confidence)

2.2 Synthesis of Indian climate change impact assessment studies

At the national level there has not been any significant work on climatic change impact assessment on water resources except the NATCOM (NATional COMmunication) (2004). The general philosophy of the implications of climatic change on the water resources of India has been discussed by Lal (2001). A general projection of the water resource demand for 2050 has been worked out by the Central Water Commission and is provided by Thatte (2000). He has shown that even without considering climate change impacts, the total water demand shall surpass the availability by 2050 even under a low consumption scenario.

There are very few other studies on climate change impact assessment. A case study by Roy *et al* (2003) deals with the impact assessment of climate change on river water availability in the Damodar basin. Hydrologic modelling for evaluation of the effect of climate change on the water scenario has been performed. The water availability in the basin under changed climate scenario was evaluated using the projected daily precipitation and mean monthly temperature data for 2041-2060. The study has drawn the following conclusions:

- Decreased peak flows would hinder natural flushing of stream channels leading to loss of carrying capacity.

- In the event of exceeding the present rate of siltation of the reservoirs and distributory channels, the dependability of the Damodar system will further worsen.
- Poor reliability depicts water-stressed condition as regards domestic and industrial demand during dry season.
- Production of non-monsoonal crops will be severely affected
- Seasonal shift in stream flow pattern will have significant negative effects on many ecosystems.
- Changes in temperature and seasonal shift of pattern of temperature in 2051 will cause shift in thermal suitability of aquatic habitats for resident species. Both these may jeopardize economy of people associated with fishing trade and agriculture.

Wilk and Hughes (2002) have used a monthly rainfall–runoff model for a large tropical catchment in southern India. Various land use and climatic change scenarios were tested to assess their effects on mean annual runoff and assured water yield at the Bhavanisagar Reservoir. Owing to the fact that the dynamics of the hydrological processes cannot be well represented by models used with temporal scales of more than a day, it is imperative that wherever possible (due to factors such as data availability) continuous hydrological models with daily time step are used.

There is one study that has been carried out to quantify the climate change impact on Indian river systems (Gosain *et al*, 2003). The SWAT model (Arnold *et al*, 1990), a distributed, continuous, daily hydrological model with a GIS interface has been used with daily weather generated by the HadRM2 control climate scenario (1981- 2000) and GHG climate scenarios (2041 – 2060). The impact of climate change on the quantity of water resources has been predicted to vary between the catchments as well as within the catchments. It may be observed that although there is an increase in precipitation in Mahanadi, Brahmani, Ganga, Godavari, and Cauvery, for the GHG (Green House Gas) scenario over the present scenario, the corresponding total runoff for these basins has not necessarily increased. This is due to increases in evapotranspiration on account of increased temperatures.

In the remaining basins decrease in precipitation has been experienced. The resultant total runoff has decreased in majority of the cases but for Narmada and Tapi. As expected the order of magnitude of such variations are not uniform since they are governed by many factors such as land use, soil characteristics and the status of soil moisture. The two basins Sabarmati and Luni show drastic decreases in precipitation and consequent decrease in total runoff to the tune of two thirds of prevailing runoff. This may lead to severe drought conditions in future.

An improved Palmer Drought Severity Index (Palmer 1965; Narasimhan and Srinivasan, 2002) has been used to quantify the drought weeks from the moisture conditions. The Sabarmati and Mahi river systems exhibit severe drought conditions under the GHG scenario. The vulnerability assessment with respect to the floods has been carried out using the simulated outflow discharge for river basins. Two river systems which are predicted to be worst affected are Mahanadi and Brahmani. The frequency as well as the magnitude of the floods is predicted to be enhanced under the GHG scenario. The magnitude of the peak flood has been predicted to be more than double in these river systems.

2.3 Impact on the policymakers and resultant initiatives

Impact of the climate change awareness in the policy arena of India has been very dismal up till now. None of the major policies that have been either revised or formulated and put in position have any mention of climate change as an additional force to be taken care of. This is true of the National Water Policy and National Watershed Development Guidelines, despite the fact that all these policies have been revised and/ or formulated very recently. The only exception is the National Environment Policy (NEP, 2006), which not only makes mention of climate change but also recommends concrete action to be taken for adaptation measures. One possible reason for India for taking a middle path is the concern that going all out to abate climate change forces should not hamper the country's economic growth.

The revelations of the Fourth Assessment Report have had much wider impact than that of its predecessor reports. There are many possible reasons for this acceptance.

- Experience of many natural events that could not be associated with the usual natural variability and are associated with climate change. In India we had a series of such events: the formation of a glacial lake in Tibet that endangered the safety of hydropower plants in Himachal Pradesh, freak floods in drought prone areas of Rajasthan and Gujarat, highly intense storms flooding the metropolitan cities of Mumbai and Chennai, etc. There are two schools of thoughts as far as these events are concerned. There is one set of people who feel that these events are nothing but events that have very low probability of occurrence and may be freak events that have been observed many times before. The other group feels that given the way the frequency of such events is increasing, they are the result of new patterns that are being developed on account of climate change forces and shall not fit into the historical hydrological regime as hydrological variability. In any case, future events shall reveal the truth but unfortunately by then we might have lost some precious time in taking the coping and adaptation steps.

- Acceptance of the climate change phenomena at the global political level by champions such as Mr Tony Blair, Prime Minister of United Kingdom, Mr Al Gore, Former Vice President of USA, and many others who have taken a lead role in creating awareness about climate change impacts.

- Continued effort for collection of scientific evidence on climate change by the global scientific community under the IPCC framework.

- Participation of countries in the energy audit, vulnerability, adaptation and mitigation studies and subsequent communications under the umbrella of UNFCC (United Nations Framework Convention for Climate Change).

However, the picture in India is improving day by day. There have been very recent developments that are very encouraging in this regard. There are instances and events involving international organisations, ministries and politicians that showcase the concern about climate change. Some of these are:

- Indo-UK collaboration through DEFRA for the climate change impact assessment in various sectors in India such as water, agriculture, health etc., starting 2000. The study started in parallel with the NATCOM study and most of the groups engaged in the specific sector studies were the same except the group on water resources that was missing in the DEFRA project. Therefore the findings and recommendations of these studies are very similar.

- Formulation of a climate change group by the World Bank in 2005 to formulate methodologies to screen projects to be funded by them with respect to the possible impacts due to climate change.

- Formulation of a climate change modelling group by the Ministry of Environment and Forests in 2006 for enhancing the capability of the country in the area of sectoral models to be used for climate change vulnerability assessment and adaptation.

- Initiation of Phase II of the National Communication to UNFCCC in May 2007 with an enhanced vigour to conduct the studies in a systematic manner by building on the good work done during the Initial Communication and attaining the level of generating achievable adaptation strategies with the Ministry of Environment and Forests as the nodal agency.

- Formulation of the "Climate Change Committee" by the Ministry of Environment and Forests on recommendation of the Finance Minister. This has been the most positive and important step in the recent past. Mr P. Chidambram, Finance Minister of India, during his budget speech of 2007, expressed concerns about the possible impacts of climate change and recommended the formulation of a Climate Change Committee at the national level to initiate studies on climate change impacts, with a view to incorporating the recommendations in the policy process. The committee was made public by MoEF on 10th May, 2007[2]. Incidentally the author is one of the members of this committee.

3. Interests and effectiveness of the state in water ecosystem services

Forest, land and water policies have often aimed to maximise the pro-poor benefits that may arise from using forest, land and water resources, but generally they have paid less attention to the impacts that changing land use may have on water availability. As a result the changes in land use, which may be promoted as part of watershed development programmes, may reduce the availability of water for downstream users. In arid areas, where water is already scarce, this can have profound impacts on more vulnerable groups. Moreover, these land use changes can result in rivers drying out completely, having significant impacts on the functioning of aquatic ecosystems (Calder *et al*, 2004a).

It is believed that many of these policy instruments, especially those being applied in association with other policies promoting irrigation and soil water conservation measures, may not be delivering the intended benefits either to the environment and water resources or to the livelihoods of vulnerable groups.

3.1 Irrigation sector

Irrigation is the oldest sector in India involved in the development of surface water resources projects, even before Independence. These projects are run of the river or storage projects of varied sizes and are categorized as major, medium or minor projects, depending on the area they command. Subsequently, another form of irrigation was added, namely groundwater or tubewell irrigation.

The total outlay on irrigation from Independence to 2000-01 has been estimated at Rs. 1,98,952 crores at 1996-97 prices, resulting in an increase in gross irrigated area of 300 per cent, from 22.56 mha in 1950-51 to 75.14 mha in 2000-01 (DLR, 2006). This puts India at the top of the list of countries with irrigated agricultural area in the world.

India has constructed around 4,400 large, medium and small dams. The majority of the dams started in the 1960s and the 1970s, the peak construction period. By now most of the good potential sites are considered to have already been exhausted and also the construction of new dams face stiff challenges from environmental groups on account of environmental impacts and rehabilitation issues. There were 410 ongoing major and medium irrigation projects at the beginning of the Tenth Plan (2002) with some of them having started more than 20 years ago, the total spillover cost to the Tenth Plan being Rs. 1,77,739 crores. As against this the total allocation for irrigation and flood control for the Tenth Plan was somewhat less, at only Rs. 1,03,315 crores. This is not a new situation and has been faced by the Steering Committees of the Planning Commission plan after plan.

There are many reasons for this situation. It starts with the design stage, when in order to justify the project through the benefit cost ratio, the costs are deliberately kept low and the design

[2] *(www.hindu.com/2007/05/11/stories/2007051102381300.htm)*

departments do not want to learn from past experience. In fact the cost overruns are accepted as a norm.

This situation of shortage of resources also has a direct impact on the poor maintenance of the existing projects because of the reduction of funds required for maintenance and rehabilitation. This in turn has a very major impact on the water use efficiency of our irrigation projects. Most of the projects are running at an efficiency of about 35 per cent which is very low by international standards (about 55 per cent is achievable).

The low efficiencies also mean that there is non-uniform distribution of water in the irrigation command. It is invariably the upstream farmers who get an adequate amount of water (usually more than their share) and the downstream farmers get very little or even no water. Most of the downstream farmers are poor and cannot exert their right on their share of water.

It is also felt that in certain cases that there is no will to complete the ongoing projects because it is a perennial source of money to the State from the Centre. It is easy to justify the expenditure since any unutilized segment of irrigation hardware construction deteriorates very fast, and fresh expenditure is justified.

Poorly maintained and managed projects also result in many ill effects. The Ministry of Water Resources puts the area affected in the irrigated commands to the tune of 1.6 mha under waterlogging, 3.1 mha under salinity and another 1.3 mha under alkalinity (NCIWRD, 1999).

The majority of the recent addition to the irrigated area is on account of groundwater development. Presently about 60 per cent of the irrigation in the country is from groundwater. Out of the 25.7 mha of the irrigated area added during 1970-90, about 85 per cent has been on account of groundwater. The share of tubewell irrigation in India has dramatically increased from 1 per cent in 1960-61 to 37 per cent in 1990-2000, the largest source of irrigation. At the global level also India attains the top position by having an annual extraction of over 150 billion cubic metres of groundwater (Shah, 2000).

The groundwater developments in the alluvial tracts of Punjab and Haryana States have reached a level where any further extraction shall be unsustainable. The Central Ground Water Board states that 60 per cent of the blocks in Punjab and 40 per cent of blocks in Rajasthan and Haryana are experiencing overextraction of groundwater (Ground Water Development above 90 per cent). If this is the situation in the alluvial part of the country with plentiful groundwater, the situation of the groundwater in the hardrock part of the country, which is about 65 per cent of the total geographic area, is very grim.

The major causes of the groundwater woes include many factors such as free or highly subsidized electricity, water pricing, and lack of any policy/ legislation on groundwater abstraction. The pity is that it is the poor who are the worst affected on account of groundwater mining by the powerful.

In India, awareness about freshwater ecosystems is not in the same manner as being advocated by the western world. Most of the freshwater ecosystem services are advocated through the religion and value system. Water has been worshipped resulting in adequate and proper maintenance of water bodies by the local communities. This may be one of the reasons that nobody cared to check whether some of the reasons used for the wellbeing of such ecosystems have turned out to be myths.

3.2 Watershed Development Programmes

In recent years, watershed development programmes promoting soil water conservation measures, forestry and groundwater-based irrigation have been termed successful in many semi-arid areas of India. Agricultural production has increased and the livelihoods of large numbers of people have been enhanced. However, this success may be short lived (Gosain *et al*, 2007).

Within watershed development programmes the implementation of soil and water conservation measures, forestry and groundwater-based irrigation schemes have generally all been promoted to local communities and NGOs as “good things”. In the right circumstances these interventions can indeed be hugely beneficial. The problems arise when these “good things” are implemented, in excess or in combination, such that the total evaporative loss from a catchment becomes close to the amount of rainfall input and the catchment approaches what is termed a “closed” or no-runoff condition. A particular feature of closure is a long-term trend towards lowering of groundwater tables, resulting in dry wells and boreholes and seasonal water shortages.

The demand for ever-increasing water supply due to change in land use and bringing more areas under irrigation is also widening the gap between the rich and poor. As the demand for water rises, shallow wells are rapidly being replaced by deep boreholes that require machinery and funds to drill. Consequently the poor are often thrust into a debt cycle where they have to borrow increasing amounts of money to extract reducing quantities of water. Stress caused by the inability to repay debts is a contributing factor to the presently very high rates of suicide amongst small farmers.

Furthermore, watershed development projects have often focused on (expensive) supply side measures directed at increasing storage, infiltration and recharge whilst doing little to manage demand. Current Government policies have actively encouraged the creation of these boreholes, often indirectly advantaging the wealthy whilst forcing others into increased poverty. Unfortunately, reduced water availability hits the most vulnerable and hence poorest communities and farmers first, often by robbing them of even the water they require to maintain livelihoods and their basic water needs. In many cases less vulnerable people have the resources to continue exploiting the diminishing water supplies, further contributing to inequitable distribution and use of resources.

A perverse and inequitable consequence of the excessive promotion of soil and water conservation measures within watershed projects is that the ownership of water may be effectively transferred from communal to private owners. Most of the soil and water conservation measures, including checkdams and other physical structures tend to reduce surface flows of water which might otherwise have flowed in to traditional village tanks for communal use. On the other hand private landowners generally benefit from the structures and interventions on their land which increase recharge and the availability of the effectively “private” groundwater that they can access.

A “sanctioned discourse” is developing within government and donor circles which are leading to watershed activities being promoted as benign technologies that are at the very least “poverty neutral”. There is evidence to indicate that the “sanctioned discourse” is pursued even when circumstances change radically, as happens when a region moves from water surplus into water deficit. In water deficit conditions there is overwhelming evidence to show that many present water-related policies and practices are doing little to benefit the poor - and little to achieve the relevant Millennium Development Goals.

The basic flaw in the watershed management programme is the fixation of the money on per unit area basis being made available to the PIAs (Project Implementation Agencies). So far these have been governmental and non-governmental organizations but under the new guidelines, Gram Panchayats have been recognized as the new implementing agencies. It may be said that this figure is only used as the upper cap but the truth is that very rarely any lesser amount has been asked for by the PIAs.

This amount on the per unit area basis which started with Rs. 4,000 per hectare and got revised to Rs 6,000 per hectare, can only be comfortably spent if construction of some structural interventions are part of the watershed development plan. Consequently with every watershed taken up the number of such structures that block the blue water keep on increasing in a drainage system.

The proponents of watershed management programmes (DLR, 2006) may feel that the budget made available for the programme is not sufficient, but in the event of the absence of a mechanism to find out the extent to which the watershed interventions in a drainage system should be allowed,

it may be a blessing in disguise. The Parthasarthy Committee (DLR, 2006) made a case of increasing the per hectare expenditure limit to Rs 12,000 despite the fact that the general findings have been that in its present form, the programme has not been successful especially for the poorest of the poor. It has been seen that some of the river systems of south India, such as the Krishna basin, have reached closure and one of the reasons is the over-implementation of the watershed programme.

Every two to three years, so-called improvements are being made in the guidelines by giving them a catchy new title, whilst ignoring all the other requirements such as providing transparency, enhancing accountability, bringing in scientific basis, making evaluation and tracking improvements to the livelihoods of the poor. Most of these aspects do not create any interest in the promoters of these programmes and invariably they claim that we are already doing all this.

4. Role and effectiveness of other parties in influencing policy that affects water ecosystem services

The major players that influence the policy which in turn influences the water ecosystems can be grouped into two categories with respect to the scale at which they operate. As explained earlier, the main players from this angle are the ministries and organisations involved in planning, implementation and management of the big water-related projects. Most of these projects, be they a major irrigation project or a hydropower project, have been in the realm of the government or at the most public sector domain. It is only recently that the private sector started participating, once the government policies were changed to woo private participation. Let us take the case of hydropower projects in India. There are many big projects which are coming up with private investment. However, there is no clear policy on environmental flows. If, tomorrow, consideration of environmental flows is imposed on a project which had not considered them during the design phase, then the whole profitability of the project might change and it might be difficult for a private investor to absorb.

Furthermore, there are many policies that may influence the ecosystem services but are never addressed. The case of interlinking of rivers is another case where despite being a mega project - the size of which has never been implemented - has not been looked at from its impact on ecosystem services. There are numerous other cases where decisions have been taken independently by the respective ministry or organisation, without looking at the possible implications. Some of the examples are.

- The intent of the MoEF to cover 33 per cent of the country with forest cover
- The recent intent of the government to cover 40 million hectares of wasteland with Jatropha plants to produce bio-diesel
- To let the Special Economic Zones (SEZ) to come up on agricultural land
- To let farmers extract any amount of groundwater free of cost with free electricity or subsidised diesel.

The other kind of players are those who work at the local scale for programmes that are again run by the central and state government departments but by involving agencies that are either NGOs of Gram Panchayats. At this scale there are more inherent problems than the earlier situation where one is concentrating on a single project. In this case, the programme is invariably widespread. However the policies are made with a view to have minimum variability, in order to get uniformity of implementation. Unfortunately, such a uniformity of implementation is detrimental for water resource related projects. Some of the past and present programmes that have faced difficulties are:

- The National Drinking Water Mission which has seen a very large number of hand pumps becoming defunct after installation

- Watershed management programme which has created problems for downstream people in many cases

- The rejuvenation of old tanks programme that has limited success due to over-doing the watershed development activities.

5. Research priorities

The research priorities of the country in the context of improving the use and sustainability of the freshwater ecosystems may be categorized under various related issues of policy, governance, and infrastructure. What has been observed in the past is that we have very good policies in position but when it comes to implementing the same policies, either the process is incomplete and faulty or the administrative and technical infrastructure is inadequate and/ or insufficient. Research is needed to address the loopholes identified in these issues so that it can supplement the intended purpose whether it is policy, governance or infrastructure.

5.1 Support for policy improvement

The policy, being an intent put together by domain experts and policy makers, is invariably a very good document that addresses all the concerns of a very wide cross-section of stakeholders. The same situation occurs with the National Water and Environment policies in India. These are very good documents in their own right. However there are few issues that are either not adequately addressed or are altogether missing. Some of these issues are briefly discussed below and might need research outputs for further support in bringing home the point.

- The National Water Policy (NWP) does talk of a river basin approach to manage the water resources effectively. It somehow does not explicitly emphasize that the same drainage area based approach should also be continued for the sub-areas of the basin, namely catchments and watersheds, that shall make it possible to address the equity and externality issues effectively.

- There is no provision in the NWP for a feedback mechanism on the implications of actions taken in the policy instruments of other sectors such as Environment, Forest, Agriculture, Watershed Development, Energy, etc. Slogans of the kind ‘Stop the water where it drops’ are made as part of some policies without even thinking about the repercussions. Intents of the kind ‘foresting 33 per cent of the geographical area’, and ‘cultivating Jatropha on 40 million hectares of land’ are made without bothering about the implications on ecosystems.

- The NWP does not even mention climate change impacts on water resources, in spite of the fact that it has been revised as late as 2002, when the general awareness of the issue was there and one of the ministries (namely MoEF) was already involved in making India’s Initial Communication to the UNFCCC.

- The NWP does not attempt to tackle equity issues and other societal issues connected with water. It only stops at providing rehabilitation to those people uprooted by big projects but is not concerned when local level interventions (many times implemented by other ministries and departments) are made and are potentially capable of creating bigger impacts on the drainage basins.

On the contrary the recently released Environment Policy (EP, 2006) provides ample emphasis and concern about water resources and the ecosystem services that freshwater ecosystems offer,

as well as the implications of climate change on water resources and the possible adaptation measures required to be put in position.

It is not true that our policy makers are not aware of these issues; it is more on account of lack of initiative and also many times due to the complexity of these issues. The initiative can also come from research organizations. The group at IIT Delhi has been part of the core group of the Forest, Land and Water Policy – Improving Outcomes (FAWPIO) programme undertaken with DFID funding. The FAWPIO recommends the development of two initiatives: Bridging Research and Policy networks and an improved ILWR framework operating in conjunction with support tools.

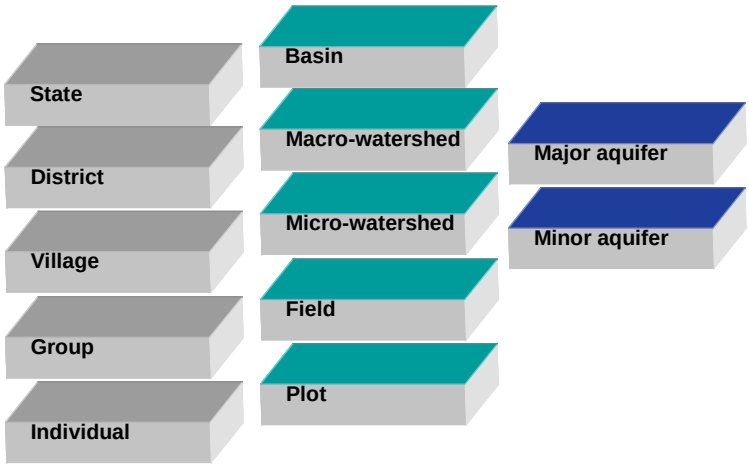
To help bridge the apparent gap between the policy and research communities and to ensure that recent research findings and policy developments can be communicated between policymakers, it is proposed that greater use be made of research networks within and between countries. These networks would aim to incorporate advocacy and promotion techniques, and to connect and disseminate new knowledge of the biophysical and socio-economic outcomes of land and water interventions to policy makers through a number of mechanisms. These would include peer-to-peer networking of policymakers, the use of interactive workshops and the use of innovative media including e-fora and electronic journals.

5.2 Support for governance

Solution to the problems and perverse outcomes identified above in relation to land and water policies and watershed development projects rests primarily in the realm of governance.

In this context governance is considered to be the range of political, social, economic and administrative systems that are in place to develop and manage land and water resources and the delivery of water services at different levels of society. The core challenge in Integrated Land and Water Resource Management (ILWRM) is that of land and water governance, particularly in relation to the deeper political and societal foundations on which day to day decisions and courses of action rest. Figure 4 illustrates that the administrative boundaries of governance systems do not match spatially with the physical boundaries of land and water systems, and should be taken into account within ILWRM (Calder *et al*, 2004b). The macro-watershed is equivalent to the catchment defined earlier and one needs to address the field and plot level as well if the objective is to address the MDGs.

Figure 4: Interaction between hydrological and administrative boundaries

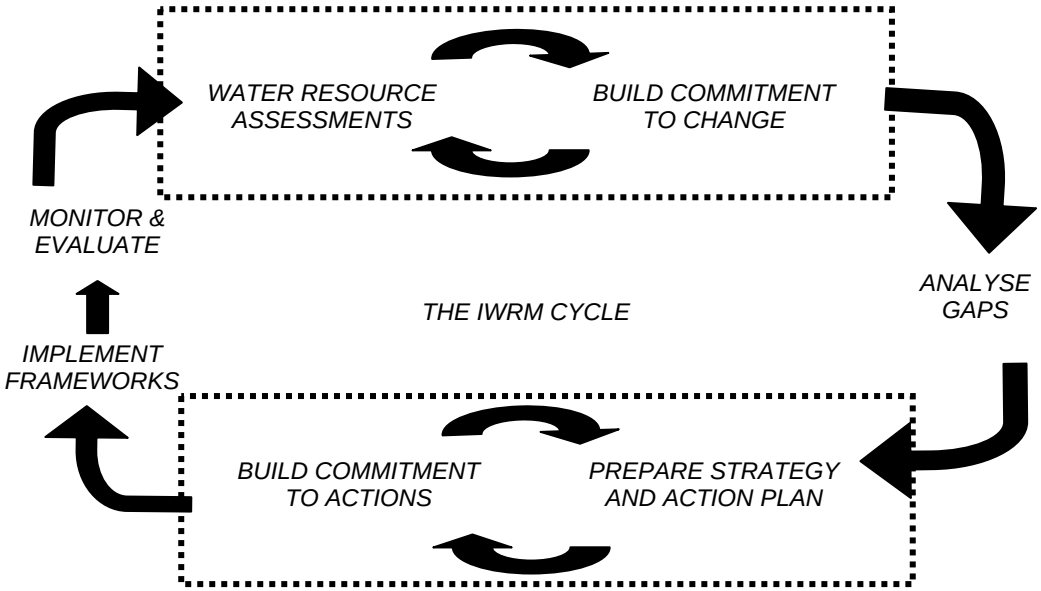


It is also recognised that difficult ILWRM decisions will have to be made if both poverty reduction and environmental sustainability are to be addressed effectively.

5.3 Support for infrastructure

Another segment that shall require maximum research initiative is to create infrastructure that shall be able to encapsulate the majority of issues described above and which shall act as a facilitator to provide a framework for integration, planning, monitoring and assessment. A typical framework, incorporating the Integrated Water Resources Management Cycle (Figure 5) shall include the following methodologies which can be operated in conjunction with support tools (Calder *et al*, 2004b). Formulation, implementation and maintenance of such a framework is truly in the realm of research and must be taken up at the earliest.

Figure 5: The improved framework for IWRM cycle



Some of the components and functionalities of such a system are:

i. Hydrological assessment of all water uses and users within a catchment.
ii. Catchment Stress Assessment to determine to what extent the catchment is approaching 'closure', or not meeting aquatic ecosystem requirements.
iii. Strategic Environmental Assessment to identify, using Social Account Matrix approaches, the economic returns and employment opportunities that arise or potentially could arise from water use in the catchment.
iv. Negotiation support, through use of a negotiation support 'toolkit', will provide to catchment water users:
v. Methodologies for contextual analysis (forest and water narratives, beliefs underlying policy),
vi. Web and GIS based dissemination tools, incorporating Blue and Green water integrating methodologies and encompassing the social accounting matrix,
vii. An 'Allocation Equity Guide', providing guidelines to support stakeholder negotiations,
viii. Environment impact assessment methodologies, primarily in relation to biodiversity and water quality,
ix. Poverty reduction impact assessment methodologies, addressing the questions: who are the winners and losers of these policies? Will the outcomes of the policy instruments benefit key poor and vulnerable groups?
x. Monitoring and evaluation. The impact assessment methodologies outlined above will also provide the basis for monitoring and evaluating the socio-economic, poverty and water resource outcomes of manmade interventions.
xi. Such a framework should be able to effect convergence of scales to encompass the interventions being made at various levels. The effective adaptation measures to climate change impacts shall only be possible through reliable simulation of the future conditions which such a common framework offers.

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