Innovative Thought Forum

LAND AND WATER

Proceedings of a Seminar

18th March 2015

1st Floor, A-7, Safal Profitaire, Corporate Road, Near Prahladnagar Garden, Ahmedabad – 380 015.

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PREFACE

Innovative Thought Forum (ITF) has been started with an aim to deliberate, decide and act on solutions to India centric problems in various domains of our society. ITF is an agnostic, non-governmental and non-political organization established with an aim to work for the welfare of Indian people. The forum is built upon the doctrine of equity for serving the humanity without any prejudice to individual(s) or any section of society on the basis of caste, doctrine, religion or economic status. The forum provides a platform for organized discussions in the form of seminars, workshops or meetings on India centric problems for precipitating either technology solutions or bring out policy level suggestions.

Our aim to confine only to India centric issues does not mean swadeshi in the sense. We mean on the other hand any solutions that is available or which needs to be imported to make a difference in the levels of ordinary people. USA is totally centric to US society, and takes decision that are good for US people and in that sense it is highest form of swadeshi. In the same sense we intend to look at our country, our climate, our ecology, our resources and our people and come out with appropriate, simple suitable and smart solutions to the complexities of our society and for the welfare of our people. Smart is a biz word today and normally people understand that smart means more efficient or we do more with less input. In that sense we like to concentrate on important subjects like land, water, energy, climate, affordable healthcare etc. However, we first decided to concentrate on the issue of land first. Land is the fundamental requirement for any activity and planning. If we frame land issues today through different sector wise interventions and activities, we find more problems than solutions, because very often these have been framed more narrowly. One such example is the SEZ, which provides different land requirements for different classes of the SEZs. Companies are getting restive over delay of their projects, mainly due to serious problems in land acquisition and environmental clearances. Government lacks a policy framework and has little internal and intra-ministerial coordination. Land is India's scarcest resource and the source of livelihood for more than half of its population. The average size of land owned by a farmer was merely three acres a decade; it is much less today. In states like Kerala, Bihar, West Bengal, Uttar Pradesh and Tamil Nadu, the average holding is between half a acre to two acres. In contrast the average land holdings is 110 acres in France, 450 acres in the US and even higher in Brazil and Argentina. India's scarcest resource i.e. land is also least productive. This is the fundamental reason for India's poverty.

Our second topic today is water, a resource that is under tremendous amount of threat. Depleting ground water table and deteriorating ground water quality are threatening the sustainability in India. The city supply water that depends on pipe water is threatened by pollution, increasing water scarcity and conflicts among users. All these problems need tangible solutions and hence one of the

important topics of our discussion today. We do hope to precipitate out a few implementable solutions out of our deliberations.

S.B. Dangayach | Rmesh Jhamtani | N.K. Bansa

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PURA: A Model for Sustainable Urban Settlements.

P.S Rana.

1. Introduction:

PURA, a model that means Providing Urban Amenities in Rural Areas, was conceptualized by my Guru, Prof. Indiresan of IIT Delhi and myself and presented to the President of India, Dr. Abdul J. Kalam at that time. In spite of several meetings and presentations across the board of various authorities in the Govt. of India, the model was not found to be implementable. The reasons are obvious, namely, the need of a critical mass to generate employment opportunities and revenue generation. A population of a few thousands of people engaged only in agriculture or labour is not sustainable economically and financially. In fact a town of less than one hundred thousand people is not sustainable from the point of view of providing facilities for higher education, health, market and any worthwhile industry. I have therefore suggested PURA to be renamed as "Planned Urbanization in Rural Ambience". The simple reason is that one requires opportunities to stay at a place. The same is true with the rural folk, who need an opportunity for better employment and to enjoy the urban amenities. I present this model here today with reasoning to develop PURA model across the cheapest and most efficient mode of transporting people from one place to another.

2. Indian Agriculture Economics & Employment.

In India more than 68% of people are supposedly engaged in agriculture. This sector consists of activities in agriculture, hunting, forestry and fishing etc. Close to half of the employed Indians work in agriculture and this sector contribute only 14% to India's GDP. This model of employment is not sustainable for any economy. In the developed countries like US and in Europe, only 1.5% to 2.5% of population is engaged in agriculture. In the major developing countries, on the other hand, the scenario is given in Table 1.

Table 1: Employment in agriculture: Scenario in selected developing countries

2003-2007	India	Brazil	China	Egypt	Mean for Developing Countries
Total economically active population in agriculture (1000 inhab)	276687	12134	510010	8594	102044
% of Total Population	25.59	6.72	38.61	11.71	29
% of rural population	35.80	40.93	64.18	20.23	47

According to this statistics, 29% of total population and 47% of rural population is engaged actively in agriculture in the developing countries of the world. In India only 25.6% of total population and 35.8 % of rural population are economically and actively engaged in agriculture. The rest of the population assigned to agriculture, either work as labourers or sit idle. It is where India needs a planned urbanization and a major bulk of her people, almost 90%, of its population need to be diverted to other occupations. This can become feasible only through integration of economic and social infrastructure and a major overhaul and radical change in our urban planning. A desirable size of an economically active town is one hundred thousand to three hundred thousands of people with diverse backgrounds.

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1. **Regional Planning (Excluding Megacities)**

In our concept of regional planning, the towns should accommodate 70% of the population; the suburbs should be located within a reach of 30 minutes to the town and accommodate 20% of the population followed by villages, which should accommodate only 10% of the population and the village to town distance should be reachable maximum in an hour. These 10% people should be employed in agriculture and the rest in other professions that are available in a suburb or in the town. With the population likely to touch 1.5 billion mark, the country needs around five thousand growth centres like this. In order to fit in to the overall country scenario, it is easy to estimate the land area to accommodate 70% of the projected urban population in the year 2050.

India's land area	- 3.256 million sq.km.
Projected population (2050)	- 1.5314 billion
Urban population (70%)	- 1.072 billion
Estimating 100 people per hectare, the required, land area to develop urban cities	- 107200 sq. km.

The area to accommodate the projected urban plan is only 3.3% of the country's geographical area.

2. **Selection of Locations.**

We are locating our habitats in a much skewed manner. The cities need connectivity and people need water. The agriculture fertile lands should be kept for productive agriculture related activities. The old Delhi for example grew on the rocky areas of Maurice Nagar, Chandni Chawk, Sadar Bazar etc. After independence, we are developing habitats in the otherwise green areas carrying water and fertility. This is one of the main reasons for sinking ground water table and water shortages.

The defined PURA town should preferably be in the vicinity of a growing city with good connectivity by road as well as by rail and a link corridor may be developed between the town and the city. Availability of water is of course one of the major considerations to select the location of a PURA town.

Depending on the population size of a town, average trip length and average per capita trip rate are illustrated in Fig.1.

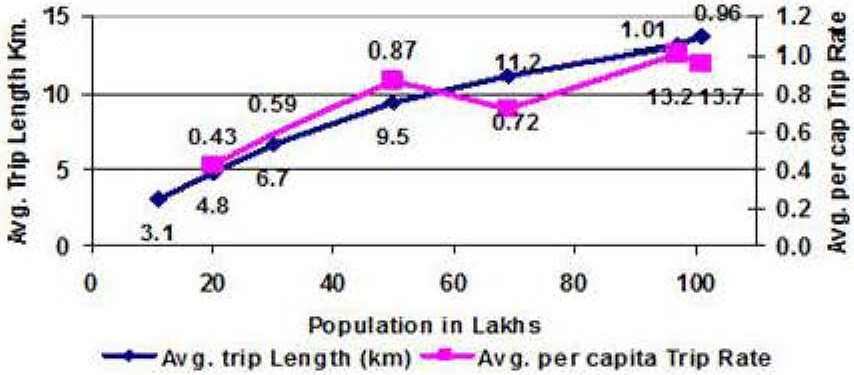

Fig.1: Variation in trip length and trip size as a function of city population

In order to select the most optimum mode of transport for link corridor of a PURA town, we examine the energy requirements for various modes of transport and the maximum capacities of various modes per lane. Energy requirements are plotted in Fig. 2 and the lane capacities in Fig. 3 respectively.

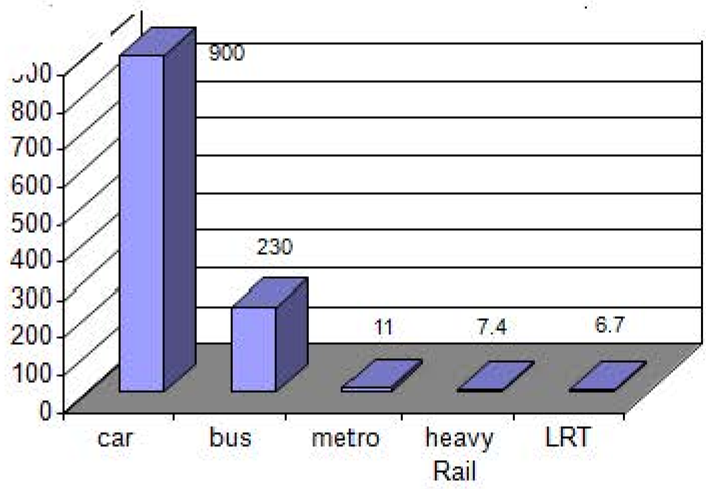

Fig. 2 : Energy requirements by various modes (Wh per passenger kilometre)

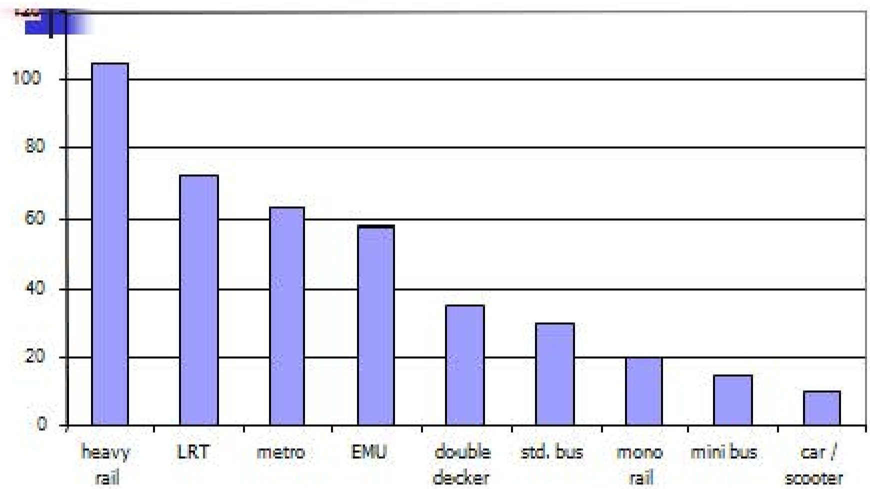

Fig. 3: Maximum capacities of various modes per lane ('000PHPD)

It is observed that a car requires maximum energy per passenger kilometre, while the LRT (Light Rail Transport), the minimum. Heavy rail on the other hand, can handle a large number of passengers per hour per day and the car minimum.

In the case of high demand, rail is the best mode of transport and also the cheapest. In the case of a very low demand, however, car is the preferred mode as shown empirically in Fig. 4.

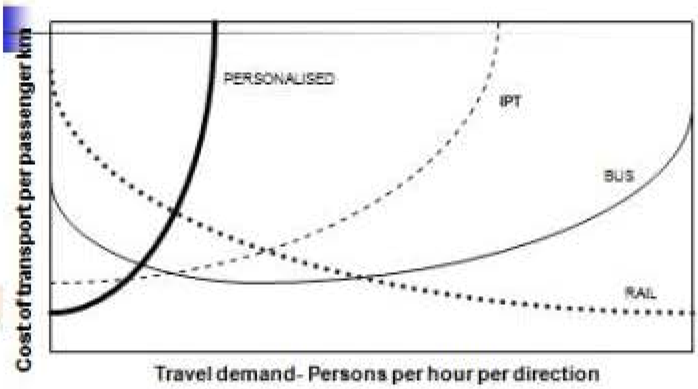

Fig. 4: Empirical illustration of travel demand and cost of transport

5. **Urban Form and Settlement Size: Development along a corridor.**

Experience shows that the cost of services increases exponentially with the size of a city. It is cheaper to have many small cities than a few big ones. Counter magnet towns identified as those that can be developed as alternative growth centres and attract migrants to them rather than Delhi, have limited success so far. Satellite towns located near Delhi or Mumbai or any other metropolitan area have also not been able to control the number of migrants to Delhi or Mumbai. Our suggestion is to develop several towns developed along a single corridor and this is the most cost effective planning.

6. **The Idea.**

The idea is to guide the development along an established corridor, which has a high density core and surrounded by low and medium density development. Rail being the most cost effective, efficient and environmental friendly transport system may be used as the corridor. Developing new urban centres may be an economically attractive solution to decongest the metros. Creation of new rail based transportation network in the existing cities requires substantial capital investments.

A concept of providing infrastructure along the two city growth centres is given in Fig. 5.

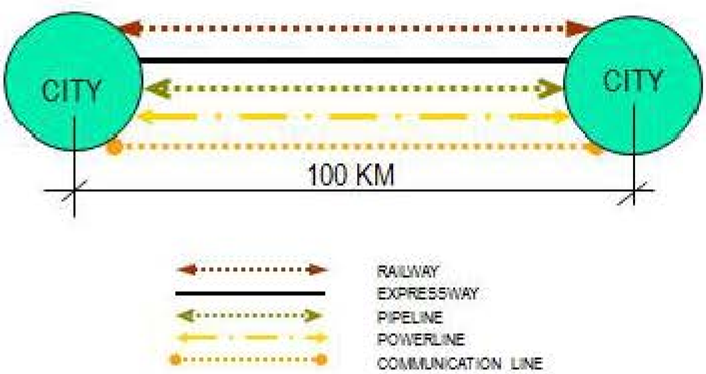

Fig. 5: Infrastructure spinal chord

A comparison of satellite town various corridor concepts is illustrated in Fig. 6

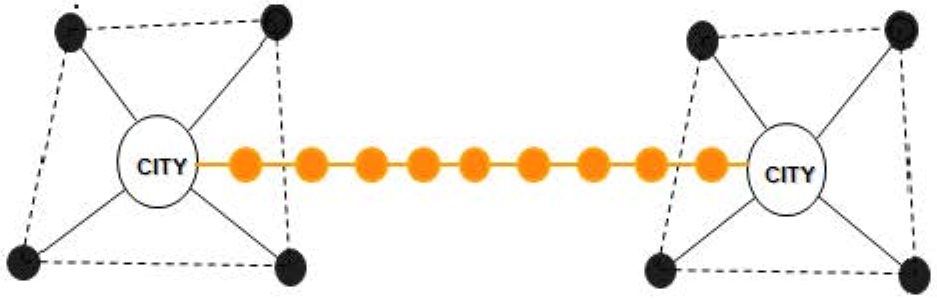

Fig. 6: Satellite town versus corridor concept

The development costs can be reduced by re-urbanizing and transforming a loop of villages in to a low cost virtual town (Fig.7).

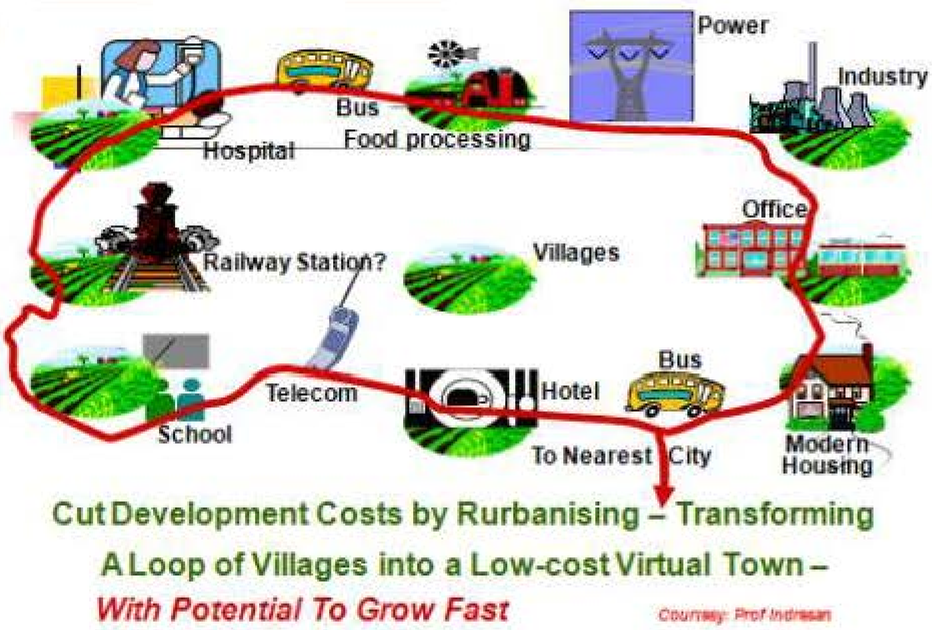

Fig. 7: Transformation of a loop of villages in to low cost virtual town

1. **NCR Potential Corridors**

An illustration of potential corridors in the NCR is given in Fig.8 and can be extended further.

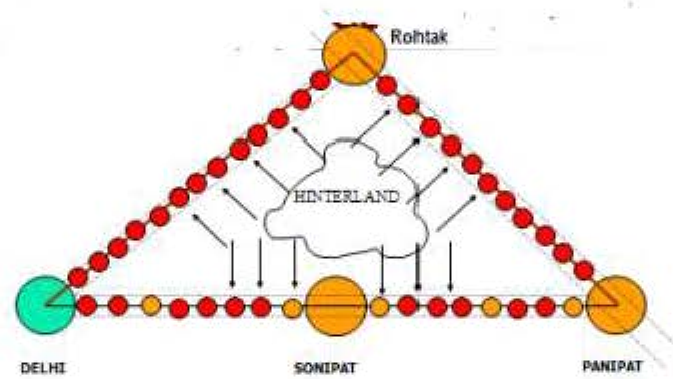

Fig. 8: Potential NCR corridors

Along with the urban plan, the policy makers need to develop in parallel an economic plan. This includes identifying local resources, skills and activities, identification of key investors and industry ancillaries The success of the plan depends upon the start of multiple economic activities such as herbal and/or agro based, dairy, poultry, meat processing and animal husbandry, food processing, BPOs, engineering, manufacturing etc. A real project will determine the value of the concept and that of the Idea. A modest beginning must be made in one of the smart cities.

Water Issues in India

A.K. Gosain

1. Introduction:

Availability of water in India is a serious problem presently and as well as in future also. The problem demands serious planning based on scientific studies. Water is a finite resource with natural variability, temporal as well as spatial. Normally the development occurs around water resources and any planned development, big or small, involves in moving water around, more often upstream. Unfortunately, development process in India is not integrated and this impacts local level resources. The core requirement is correct assessment of demand and availability of water resources at the local level as well as at regional levels, namely at the river basin level. In India, there is no definite policy yet in place on water demand assessments, availability at the river basin except Ganga now and the tradeoffs that influence water resources. The corresponding environmental concerns have been ignored for a long time; it is only recently that issues are being tackled through various ministries. These various ministries involved with different issues and run many parallel programs with competing demands such as water shed management, rainwater harvesting and industrial development etc. There is, however, no mechanism for tradeoffs between competing demands and coordination between the ministries become very often a problem.

Most severe problem that India faces presently is to ensure the sustainability of water resources in terms of both quantity as well as quality, which is about maintaining the hydrological and environmental health of our river as well as the drainage system. The philosophy of the Indian Water Resource Management (IWRM) has been the option of using scientific methods; in practice, however they have been seldom realized. A river basin is a natural system, where water balance can be resolved and thereby impacts of manmade interference quantified. River basin is a hydrological unit and unfortunately most of our hydrological systems are not working efficiently.

2. Present Status of India's River Basins.

Our river basins presently are not doing the environmental function that they are supposed to do. In bad monsoon years, water from rivers does not go to the sea. The eco-balance however demands river water flows to the sea maintaining the delta fertile. In the absence of water not flowing to the sea, the sea water flows back and affects the fertility of the delta. Maintenance of river and sea water balance ensures fertility of the land.

In order to develop an Integrated River Basin Management Plan, a number of actions are required to be taken. These actions include:

- Assess temporal as well as resource availability.
- Assess present and future demand.
- Maintain efficiency of projects like irrigation etc.
- Assess environmental status.
- Develop pathways with and without climate change.
- Formulate information and develop sharing mechanism.

3. The Scientific Base.

The actions suggested above require deployment of different models, namely, hydrological model, ground water model, hydraulic model, water quality model, environment model and system model. In addition, a framework needs to be established to allow interoperability of all these models that are meant for different tasks.

3.1 Hydrological Model

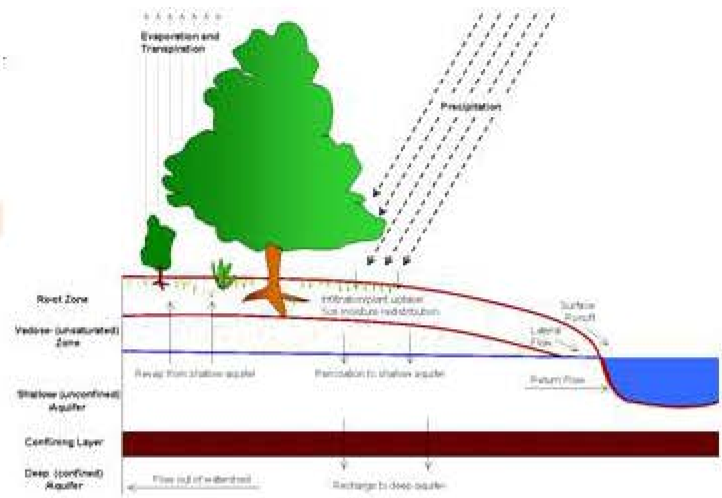

Fig. 1: Components of hydrological model

Fig. 1 shows the basic concept of a hydrological model that has several inputs like rainfall, evaporation and transpiration, water flow (monitored by Central Ground water Commission). The model uses available data in terms of continues time values or in the form of time series and forecasts the present and future flows at locations where there are no measurements. Two major types of hydrological models can be distinguished:

- **Stochastic models** are black box systems, based on data and using mathematical and statistical concepts to link a certain input, like rainfall, to the model output like runoff. Commonly used techniques are regression transfer functions, neural networks and systems identification. These models are known as stochastic hydrology models.
- **Process Based Models**: These models try to represent the physical processes observe in the real world. Typically such models contain representations of surface run off, surface flow, evapo-transpiration and channel flow. These models can be far more complicated and these are termed as deterministic hydrology models.

Again one can have either hydrological transport model which describes the flow and routing of water once it has entered a river/stream and the transport of dissolved or suspended material and debris in a river/stream system. The distributed hydrological models are grid based and take into account the spatial variability of meteorological input and other inputs like terrain, soils, vegetation and land use. In these models run off generate in a grid cell is transported downstream through a grid cell to grid cell network using the local drain direction of each grid cell. Many models combine the two models to get a better output.

4. **<u>Major Hydrological Studies at IIT, Delhi.</u>**

Two major studies were assigned to the IIT Delhi in the last few years namely:

- Climate change impacts on water resources as a part of India's National Communications (NATCOM) project to UNFCC coordinated by the Ministry of Environment and Forest (2004-12).
- Ganga River Basin Management Plan dealing with the hydrological and groundwater used modelling.

Fig. 2 Shows the base layers of Ganga Basin used for hydrological modelling. The top left figure shows the base terrain and the bottom left shows land use of Ganga basin. Sub basin configuration used in the hydrological modelling is shown on the right top and the bottom right is the soil map.

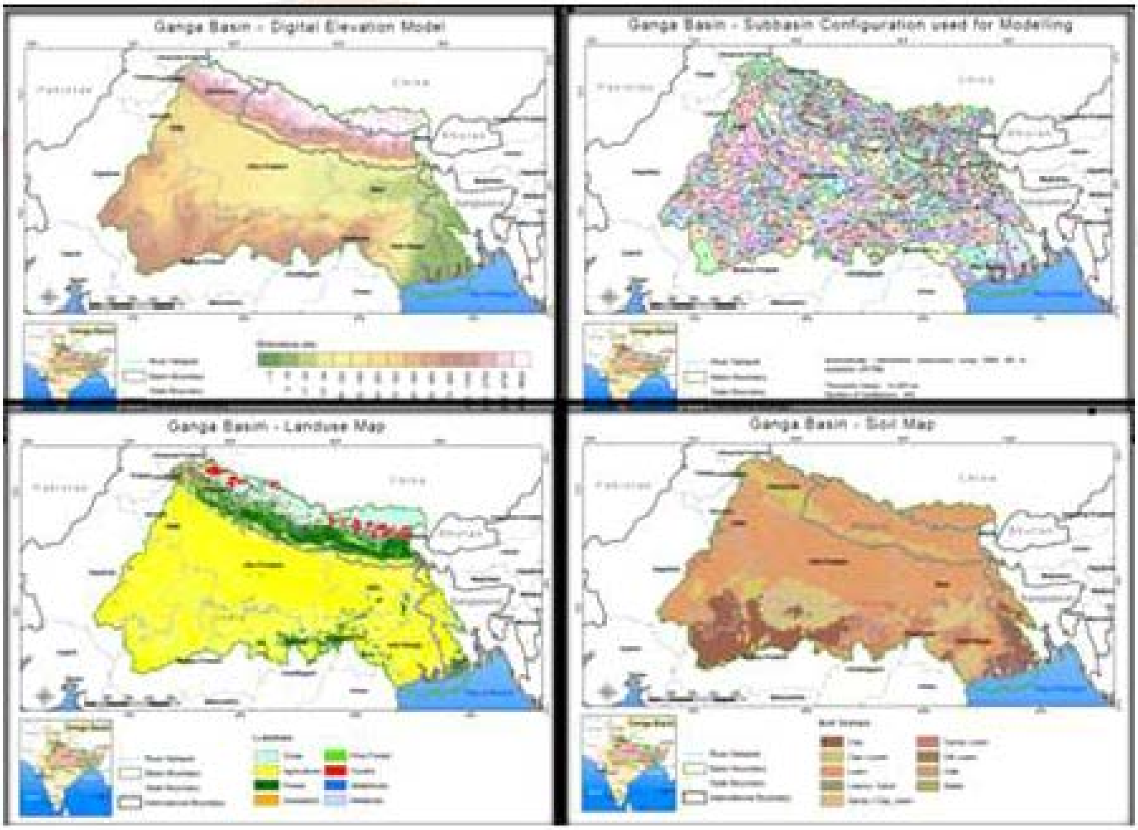

Fig. 2: Ganga basin hydrological modelling: Base layers

The division of Ganga land in small areas is done in a way that a local unit is a combination of land and soil. Millions of such units are used in the hydrological modelling. Fig. 3 shows the output of hydrological modelling for Ganga river basin showing average annual water yield, precipitation and annual average ground water recharge. For each smaller area huge outputs are obtained. We also found the original ground water table as well as the virgin flows by avoiding the man made interferences.

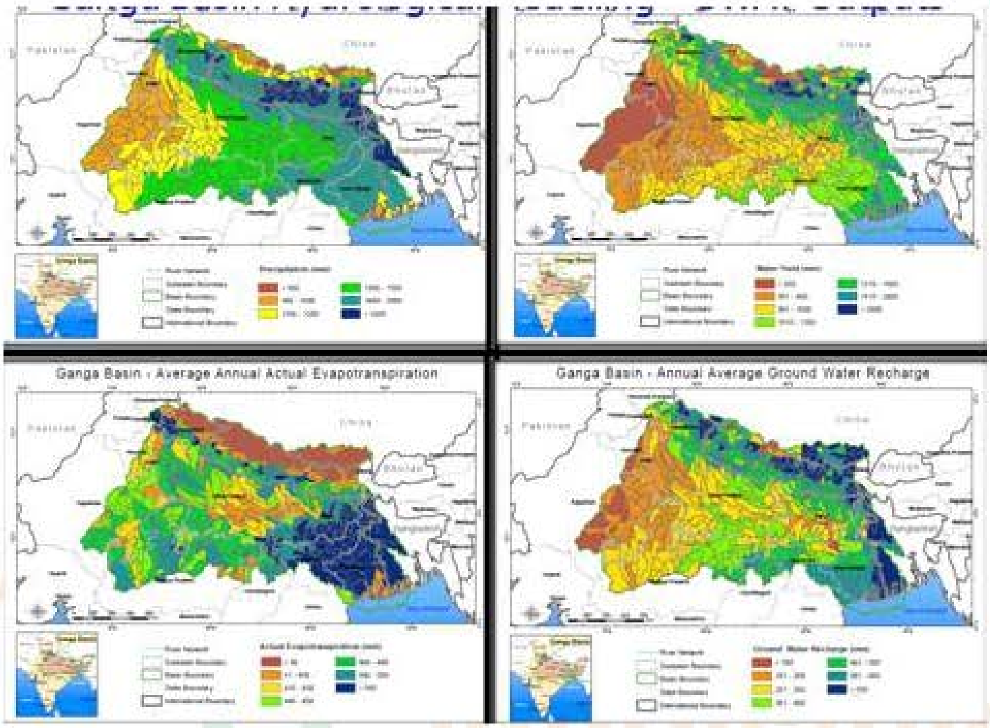

Fig. 3: Ganga basin hydrological modelling: SWAT outputs

All developments were switched to find the original water table and the flows. The results are shown in Fig. 4. The top left and right figures show the pre and post monsoon ground water table respectively. The bottom figures show the same for the virgin case. One can observe that the water table has greatly gone down in the business as usual scenario

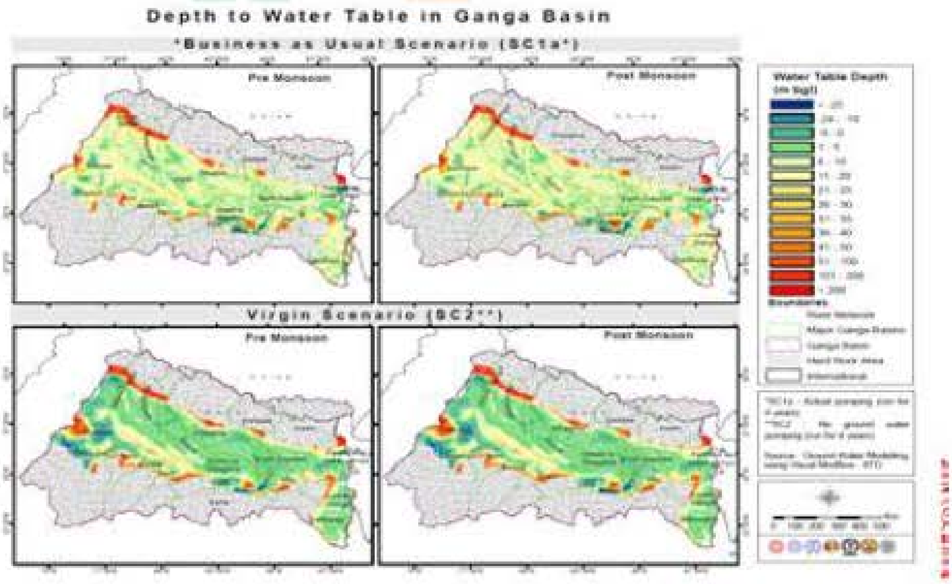

Fig. 4: Depth of water table in Ganga basin: Present and the virgin case.

If one wishes to ask a question regarding the revival of flows then again one has to study the flows in the virgin case version the present ones. The results of surface and ground water interaction for virgin and present cases are shown in Fig. 5. Due to immense ground water pumping one can observe a large number of losing streams and reduction in the gaining streams.

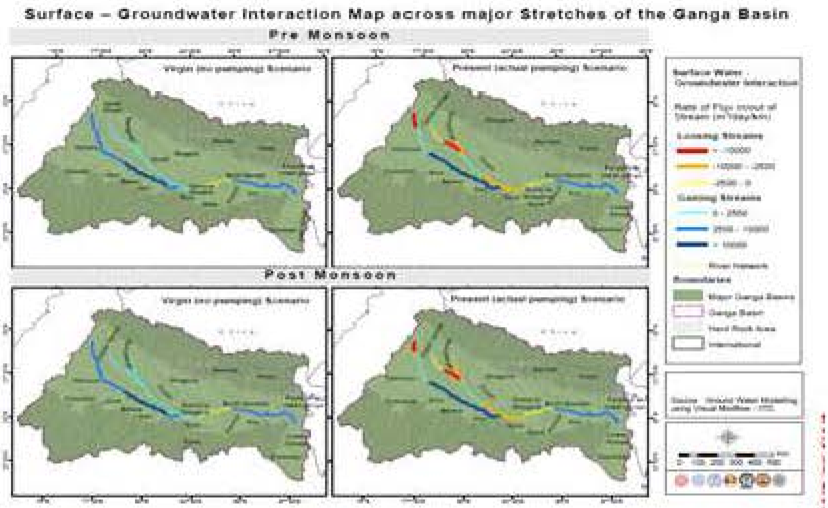

Fig. 5: Surface and ground water interaction: Present and virgin case

The models that are being used by us for ground water as well as surface water mapping can also be used effectively for other purposes like rain water drainage and sewage systems for example in Delhi. IIT Delhi was entrusted with the task of drainage master plan of Delhi, which consisted of natural as well as artificial storm drains. Major culprit in Delhi has been the mixing of storm water and sewage water. There is no drain in Delhi without sewage. Fig. 6 shows all red lines that were planned for storm water drains but all these carry sewage. Also storm water drains are supposed to run only during the rainy season. Also many of these drains have already been encroached and disappeared.

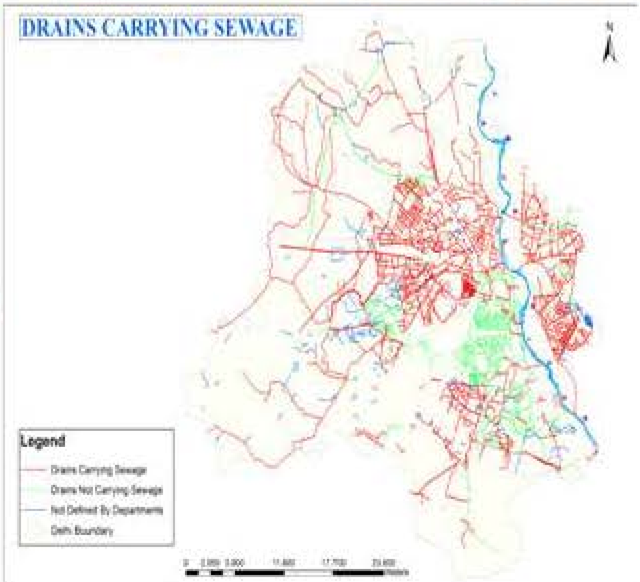

Fig. 6: Drainage master plan of Delhi: Fate of natural and manmade storm drains

On confrontation with DJB only 21 drains falling in to Yamuna are defined as natural drains. There were actually 201 natural drains in Delhi in 1976 but all carry sewage. Forty four drains have disappeared since then IIT Delhi is trying to simulate Delhi to find out the reason for flooding during the rains. Is the drainage system of Delhi sufficient to handle sudden heavy rain water or not? However, the problem is acute because fifty five percent of Delhi is un-sewaged. DJB had put up a master plan to provide sewage costing 21000 crores and to take 21 years for completion of the project.

On our suggestions to trap the sewage from these colonies and put it in the main sewage line reduced the completion period to three years and the costs reduced to 4000 crores.

5. The major requirement.

Our aim should be to keep pace with the fast changing baseline. A common frame work is required to provide an integrated information base procedure. Tools are available for monitoring the scenario and the evaluation of the results. We have analysed the impact of climate change on availability of water resources. The modelled river basin provides detailed outputs that include the entire water balance component at spatial and temporal scales, which are analysed for changes in magnitude and frequency of flood peaks, severity of droughts, changes in flow patterns and changes in ground water recharge. Based on the modelling results, percent change in precipitation across India is shown in Fig. 7 and percent change in water yield in Fig. 8. It can be observed that north and central parts of India my get more water yield by the end of century, where as southern part may not get any major yield as compared to the base line.

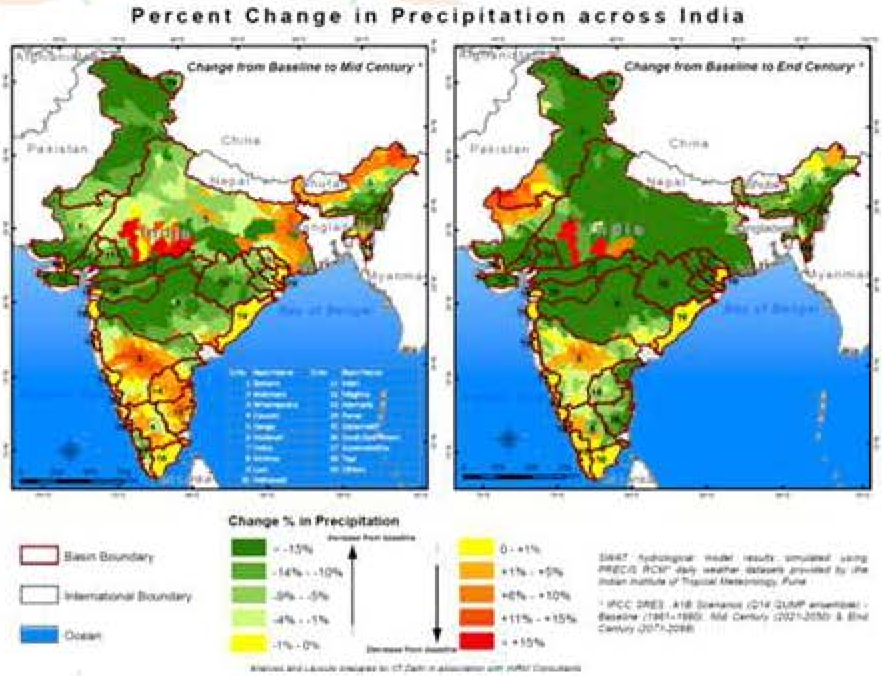

Fig8: Percentage change in precipitation across India

Similar results are obtained for evapo-transpiration, sedimentation and drought scenarios also. IIT Delhi will be involved in studying other basins in collaboration with Central Water Commission, namely, Narmada, Palar, Mahi and Yamuna up to Etawah. Our aim is to tackle issues in an integrated fashion and plan water resources scientifically rather than in an ad hoc fashion. We need to use water in conjunction with the health of the respective hydrological basin.

Key Issues of Land Use in India and Implications for Policy Planning.

Vijay Paul Sharma

1. Introduction

Land is the most important resource in any development process and its national use needs to be ensured in any planning process. I have therefore chosen to speak on the key issues of land use in India and its implications for the policy formation. I will concentrate on the main topics, namely, political economy of agriculture and land use policy, land use pattern in India, its current status and emerging issues and the way forward to improve land use for the growth of Indian economy and better rewards especially for marginal farm size owners.

2. Political Economy of Agriculture and Land Use Policy.

The Indian economy has undergone major structural transformation after the independence which is necessary for any development process. The actual transformation has happened only after the new economic reforms were introduced in the year 1991 to introduce economic liberalization with the goal of making the economy more market oriented and expanding the role of private and foreign investments. In the post liberalization processes however, the problem of market linkages have emerged due to shrinking and fragmented farm sizes. To improve the situation one needs to introduce land reform which requires political economy at the state level because land is essentially a state subject.

The share of India's economy sectors has changed dramatically in the last four decades (Fig. 1). In the year 1963-64, agriculture contributed about forty five percent to the Indian economy, which reduced to 28.2% in the post reform period 1993-94 and presently agriculture contributes only 13.9% to the economy. However, agriculture employs more than half of the Indian workforce involving 138 million households.

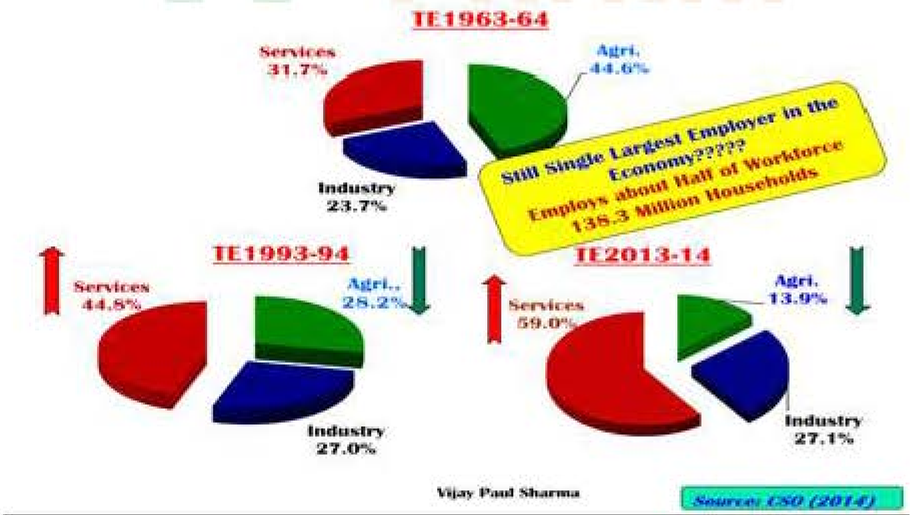

Fig.1: Changes in Sector wise contribution to the National GDP

Agriculture therefore remains the single largest employer in the Indian economy contributing monetarily much less. The situation therefore is not sustainable and there is a need to upgrade the skills of a section of this workforce to be shifted to other sectors like manufacturing and services. Simultaneously there is a need to improve the productivity of our farms.

3. Marginalization of Farms.

In the post economic reform period, the average farm size has been declining leading to fragmentation of farms. Fig. 2 gives an overview of the increase percentage of farm size of less than one hectare and this number is still increasing due to various reasons. In the year 1970-71, percentage holding of less than one hectare farm size was 50%, which has increased to almost 75% now. Such small farm sizes are not suitable for competing markets and these are also not economically viable. According to one study, the minimum size of an economically viable farm should be at least be 1.5 hectare.

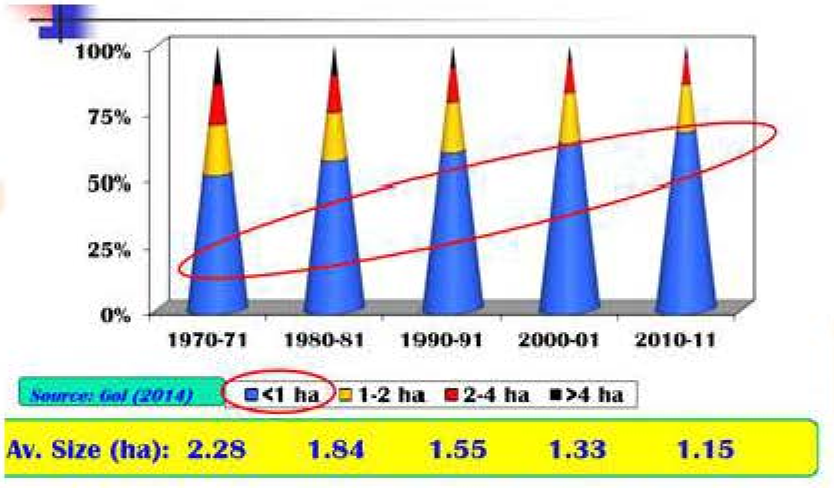

Fig. 2: Increasing number of marginal farms; Problems in linking to the modern market food chains

With respect to the farm size, there are considerable disparities amongst the states. For example from Fig. 3, one can see that Punjab has highest size of an average farm, equal to almost four hectare; Kerala on the other hand has an average size of only 0.25 hectare.

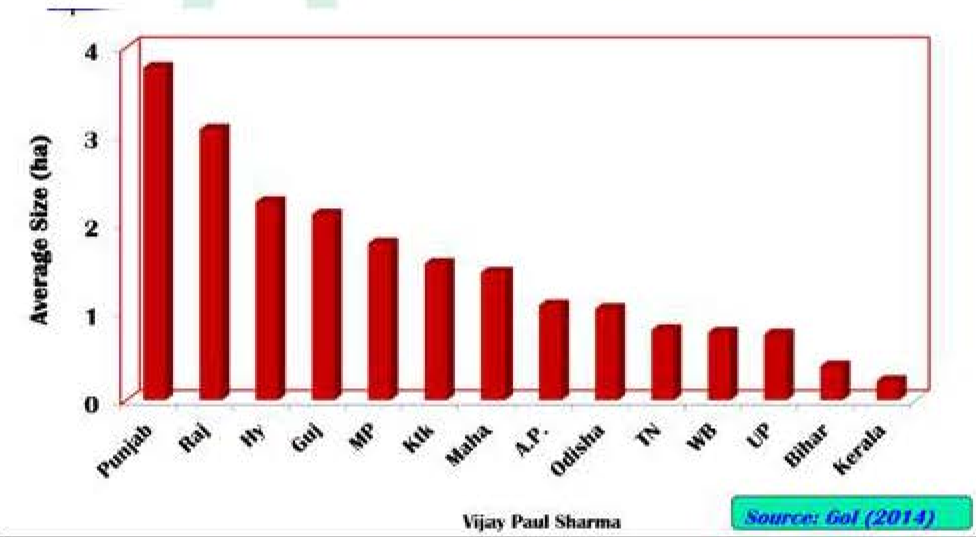

Fig. 3: Average farm size in various states

Fig. 4 gives the economic variability of a farm size. A large farm is much more economically viable than a small farms. The overall economic viability of all our farms is therefore very low.

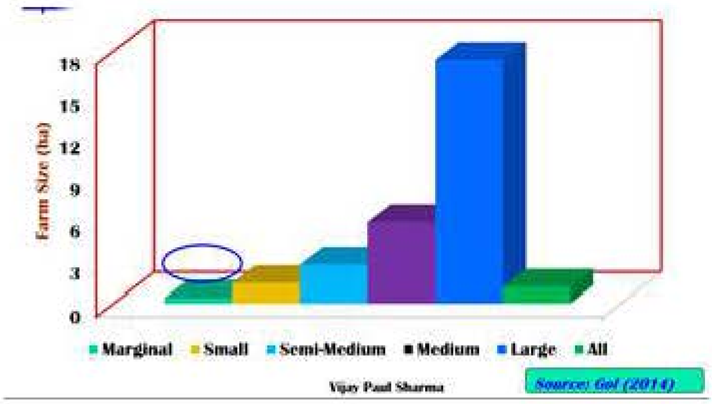

Fig. 4: Farm size and economic viability

4. Addressing the Issue of Small Farm size

There are several solutions to take care of the problems of small farm sizes such as:

- Liberalise land ceiling limits.
- Land tenancy reforms
- Land consolidation

Liberalization of land ceiling limits is neither desirable now feasible. The land tenancy reforms need a very strong political will. In rich states, land tenancy is allowed with and without restrictions, while in other states land tenancy is not allowed. Table 1 provides an overview of land tenancy laws in various states of India.

Table 1: Land Tenancy Laws in the Indian States.

Restrictions on land tenancy	States.
-Legally prohibited	Kerala and J&K.
-Leasing allowed by certain category (disabled minors, widows etc.)	Bihar, Jharkhand, MP, CG, UP, Orissa, Uttarakhand, Telengana.
-Not banned but tenant acquires right to purchase the land after some period of tenancy.	Punjab, Haryana, Gujarat, Maharashtra, Assam.
-No restrictions	Andhra area of AP, Rajasthan, Tamil Nadu, West Bengal(share cropping only)
-Transfer to non-tribal permitted by an authority	Scheduled tribal areas of AP, Bihar, Odisha, MP & Maharashtra

It is observed that there are ten major states, where tenancy is prohibited. It will be advantageous to formalise land tenancy in all the states protecting the rights of owners and making the cropping area more productive.

5. **Land Use Pattern in India: Current Status and Emerging Issues.**

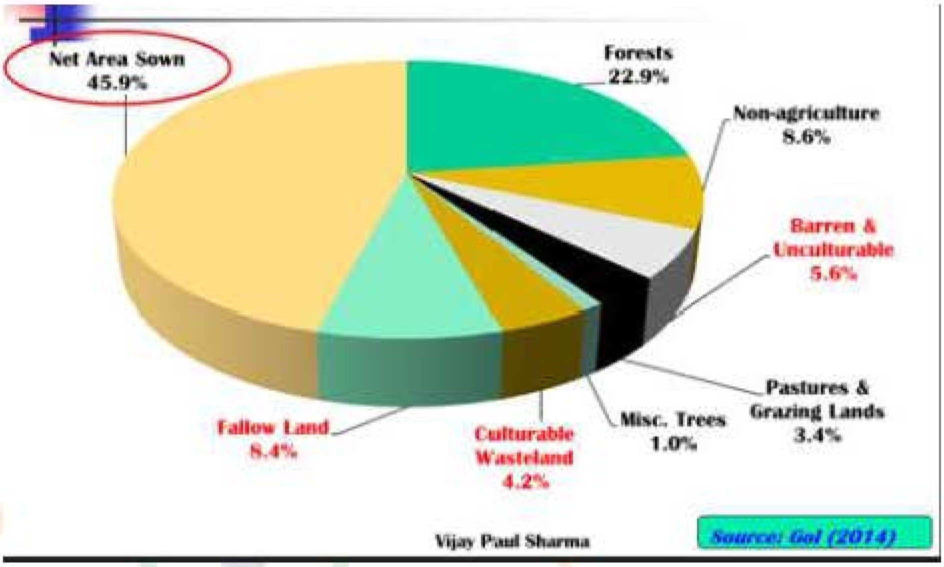

Fig. 5: Land area in different categories (Reported area 305.8 million ha)

Fig.5, shows the percentage of land use area for various activities in the reporting land area of 305.8 million hectare in the year 2011-12. The net sown area used 45.9% of the entire land. The exact figures about the availability of land resources for different purposes are given in Table 2.

Table 2 : Availability of Land Resources (GOI 2014)

	Area (million hectare)
Reporting area	305.2
Forest land	69.8
Non-agriculture uses	23.9
Barren and un-cultivable land	17.5
Permanent pastures and other grazing lands	10.5
Land under Misc: Tress & grives	13.6
Net sown area	138.0
Total cropped area	182.4
Cultivable waste lands	3.4
Fallow land	28.4

The table shows that the net cropped area is more than the net sown area because of multi-cropping practices in well irrigated farms. Extension of irrigation facility will therefore certainly increase the crop yield in farms that still depend upon the rains.

As the economy grows, the competition for various land use also grows. There are growing demands for manufacturing, infrastructure, real estate, mining etc. There is a competition in the agriculture use itself like between food and fodder. There is an increasing demand for fodder and more land is required for growing meat and milk production. Similarly the growing demand for fibre requires more land for growing cotton. It is therefore necessary to prioritize the land use depending upon the capacity of the land and the land owner. Fig. 6 shows the pattern in decreasing net sown area and the increasing land area under non-agriculture use in the post liberalization period in the country..

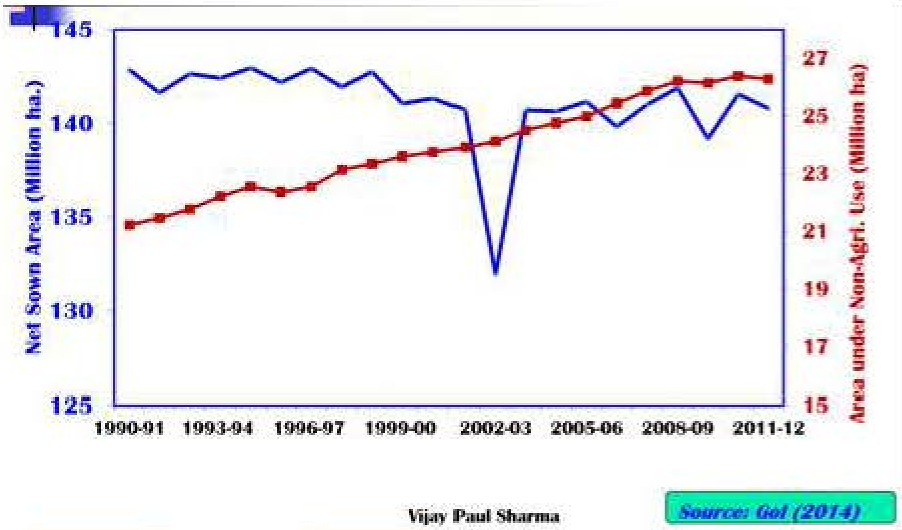

Fig. 6: Variations in the net sown area and area under non-agriculture use

The exact figures, for reduction in net sown area in various states, are given in Table 3. In some states, however, like Rajasthan, the NSA has increased due to conversion of fallow lands to lands for agriculture purposes

Table 3: Changes in Net Sown Area (NSA) : State Level Analysis (2001-02 and 2011-12) (GOI 2014)

Reduction in NSA ('000 ha)	States.
* Greater than 500	Odisha (1304) – mainly due to increase in area under non-agriculture use and increase of fallow lands.
* 100-500	Jharkhand (382), Tamil Nadu (369), West Bengal (325), Bihar (335), U.P (211) , Kerala (148), Chattisgarh (114)
* Less than 100	Punjab (88), Uttarakhand (52), Haryana (21), H.P (13)
* In NSA greater than 500	Rajasthan (1740), Gujarat (803), due to decrease in fallow lands
* In NSA less than 500	A.P, (68).

6. The Way Forward

Land is the most important asset for poor people. The people must have a say and participation in the process of policy making process. It is not desirable to direct productive farm land for non-agriculture purposes. There is a need to bring waste lands & fallow lands under cultivation by using proper technology and creating necessary infrastructure. One should also make efforts to improve cropping intensity up to at least 132%.

For non-agriculture purposes, it is desirable to use barren and uncultivable lands, like waste lands, fallow lands etc as far as possible with in the demography of a region. In order to improve the viability issue of liberalization of land ceiling the government should promote it through corporatization of farming viz a viz tenancy reforms. States should facilitate land leasing by making required legal changes. Land consolidation should be made mandatory. It is very essential to modernize land records.

The cross-competition of land use within in the agriculture requirements as well as between agriculture and non-agriculture economic activities should be managed efficiently with respect to the land utilization. Various activities should be planned to complement each other rather than compete with each other negatively.

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Brainstorming on "LAND & WATER"

18th March 2015, at India Habitat Centre, New Delhi.

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