CHAPTER-IV

SPATIAL ANALYSIS OF IRRIGATION IN KARNATAKA

RIVER PROJECTS
SPATIAL ANALYSIS OF IRRIGATION
INTENSITY OF IRRIGATION
DEVELOPMENT OF IRRIGATION
IRRIGATION POTENTIAL
SOURCEWISE TRENDS IN IRRIGATION
DIVERSION OF RIVERS AND POLICY IMPLICATIONS
REGIONAL TRENDS IN TANK IRRIGATION, THEIR RESTORATION
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PROBLEMS OF GROUND WATER DEVELOPMENT
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CHAPTER-IV
SPATIAL ANALYSIS OF IRRIGATION IN KARNATAKA

It is estimated by the hydro engineers that Karnataka has nearly one crore hectare metres of water flowing in its rivers. Out of which it is estimated that nearly 50 lakh hectares of water can be utilized. As a result of which nearly 42 lakh hectares of land can be irrigated in Karnataka. In this regard the two river systems like Krishna and Cauvery are most important. These two river systems have covered nearly 80% of the geographical area of Karnataka. In these two river systems, it is estimated that nearly 3400 t.m.c. of water is flowing.

Since 1966, the department of Geology and Mines of Government of Karnataka has started to survey the underground water capacity and it is estimated that 11416.12 million cubic meters of underground water is available in Karnataka. Out of which 8812.15 million cubic meters of water can be used for irrigation and thereby 10 lakh hectares of land can be irrigated.

The tank irrigation system in Karnataka was in use during the historical period. By 1951 Karnataka had an area of 1.14 lakh hectares of land under irrigation. This was nearly 6% of the net sown area. By development of irrigation projects in Karnataka by the end of the year 1979, nearly 14.09 lakh hectares of land was under irrigation.

The expansion and development of all the irrigation projects in Karnataka has now (2003-04) provided irrigation facility to nearly 24.50 lakh hectares of land, which being 21.24% of the total net sown area of Karnataka. This is less than 33.3% of all India irrigated land. Out of total irrigated land of India, the share of Karnataka is only 4.4% and it ranks 10th among Indian states. Among the South India states Andhra Pradesh and Tamil Nadu are ranking 1st and 2nd while Karnataka is in 3rd rank.

As per the data of 2002-03, out of total irrigated land, nearly 31.5% of land is irrigated by river canal irrigation. Due to extensive use of electricity to pump out the water from the wells, the land under well irrigation in Karnataka has reached to the extent of 48.3% of net sown area. In addition to this the tank irrigation shares 7.4% while other sources of irrigation share 12.8%. The other types of irrigation include lift irrigation, sprinkle irrigation, drip irrigation and spring irrigation.

**K.R.S. Irrigation Project**: A dam built across river Cauvery, in Mandya district irrigated nearly 77,000 hectares of land in the taluks of Mandya, Pandavapur,
Srirangapatna, Maddur, Nagamangala, Malavalli and Mysore. Further it is estimated to increase nearly 32375 hectares of land under irrigation under K.R.S. project, through Varana canal project. This Varana canal project will irrigate the taluks like Hassan, K.R.Pet, Pandavapur, Nagamangala, Maddur, Mandya, Krishnarajanagar, Tiptur, Turuvikere, Gubbi, Kunigal and Tumkur. Under Hemavathi river project, which being a tributary of river Cauvery, the canal constriction work is in progress and it is estimated to irrigate 2.63 lakh hectares of land belonging to the taluks of Arakalgudu, Holenarasipur, C.N. Patna, Hassan, K.R. Pet, Pandavapur, Nagamangala, Maddur, Mandya, Krishnarajanagar, Tiptur, Turuvikere, Gubbi, Kunigal and Tumkur.

Under Kabini river project which being a tributary of river Cauvery, will irrigate 89000 hectares of land, when completed, to the taluks of Heggadeedevanakote, Nanjanagudu, T.Narasipur, Yelandur and Kollegal. Under Harangi river project, which being a tributary of Cauvery river is irrigating 53000 hectares of land belonging to the taluks of Arakalgudu, Somavarpet, K.R.Nagar, Piriyapatna and Hunasur. Under Nugu river project, which is a tributary of Kabani river, an area of 10500 hectares of land belonging to Nanjangudu taluk is being irrigated.

Under Vedavathi river project (called as Vanivilash Sagar) which being tributary of Tungabhadra, an area of 10000 hectares is being irrigated. The Tungabhadra river project built in Hospet taluk irrigates 3.92 lakh hectares of land in Karnataka, belonging to the district of Bellary, Raichur and Koppal. The Bhadra river project, which being a tributary of Tungabhadra river irrigates 97700 hectares of land in taluks of Tarikere, Bhadravati, Channagiri, Honnalli, Davangere, Harihar and Harapanahalli. Under Tunga river project, which being a tributary of river Tungabhadra irrigates 8700 hectares of land, belonging to the taluks of Shimoga.

The Ghataprabha river being tributary river of Krishna has dam across Ghataprabha river in Hukkeri taluk at Hidakal. It is providing irrigation to the extent of 290280 hectares belonging to the taluks of Gokak, Chikkodi, Athani, Hukkeri, Soundatto, Ramdurg, Raybag, Mudhol, Jamakhandi, Bilagi, Bagalkot, Hunagund and Badami. The river Malaprabha is another important tributary of river Krishna. A dam across the river Malaprabha is built near Soundatti. It irrigated 2.14 lakh hectares of land belonging to the taluks of Soundatti, Ramdurg, Naragund, Hubballi, Badami, Naragunda, Gadag and Ron. The upper Krishna river project consists of two dams built across the river Krishna, one at Almatti and another at Narayanapur. The total land of 8.43 lakh hectares belonging to the taluks of Bijapur district, Bagalkot district,
Gulbarga district and Raichur district is being irrigated by upper Krishna project. **River Karanja, a tributary** of river Godavari has got a dam in Bhalki taluk in Bidar district, which irrigates 58745 hectares of land of Bidar district. **The Varahi river project**, in Kundapur taluk provides irrigation to the extent of 15700 hectares of land belonging to Udupi and Kundapur taluks. **The Bennetora project** being part of the Bhima river basin has got dam in Chittapur taluk of Gulbarga district, which provides irrigation facility to 20200 hectares of land belonging to Chittapur taluk and Sedum taluk of Gulbarga district.

The spatial analysis of talukwise percentage area under irrigation (2003-04) shows 8 taluks under very high range of irrigation i.e. more than 72%. Out of these 8 taluks 3 taluks viz., Raybag (93.69%), Gokak (86.64%) and Bilagi (74.80%) belong to Krishna river basin. Out of these 3 taluks Raybag and Bilagi taluks get irrigation water from Krishna river basin through lift water system of pumpsets, apart from Ghataprabha river canal water brought from Hidakal dam. In case of Gokak taluk the water brought from Ghataprabha river (Hidakal dam) canal is only available. Three taluks in Cauvery river basin viz., Yelandur (78.16%), K.R.Nagar (77.98%) and Mandya (75.15%) receive irrigation water from K.R.S. project as well as Kabini and Harangi river projects. The Harihar taluk (87.81%) receives irrigation water from Tunga river project while Bhadravati taluk receives water from Bhadra river project. In all these 8 taluks of very high range of irrigation, water from borewells and from small streams is also made available by the farmers and consequently these 8 taluks have made much headway in irrigation extent.

**High Range of Irrigation** : In this category 21 taluks are observed, where irrigation is available in the range of 49.8% to 71%. Three taluks i.e. Jamakhandi (69.98%), Madhol (68.05%) and Athani (57.85%) get water from Ghataprabha project while Sorapur taluk (of Gulbarga district) gets Krishna water from Narayanapur dam. Gangavati taluk (69.27%), Bellary taluk (67.61%), Hospet taluk (62.51%) and Sindhanur taluk get water from Tungabhadra river project.-Five taluks of Dakshina Kannada district i.e. Bantwal (61.05%), Puttur (53.78%), Belthangadi (53.15%), Mangalore (52.69%) and Sulya (51.55%) get irrigation water lifted from perennial streams as well as bore wells. Another 3 taluks of western ghat region i.e. Sagar (55.66%), Tirathalli (49.24%) and Honnavar (54.70%) receive irrigation water from Tunga project, Bhadra project and perennial streams respectively. Davangere taluk (55.65%) located in central part of Karnataka gets water from Tunga project for
KARNATAKA STATE
TALUKAWISE AREA UNDER IRRIGATION
(Range in Percent)
As per the data of 2003-04

Very High (Taluks-8)
Above 72 Percent

High (Taluks-22)
49.8 to 71 Percent

Medium (Taluks-44)
28.4 to 49.7 Percent

Low (Taluks-87)
7.1 to 28.3 Percent

Very Low (Taluks-15)
Below 7 Percent

Data Not Available
Table No. 39
Karnataka
Taluka Wise Percentage area under irrigation
2003-2004
Descending order

Net Area irrigated = \( \frac{\text{Net Sown Area} \times 100}{\text{Net Sown Area}} \)

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### KARNATAKA STATE

#### Talukawise Percentage Area Under Irrigation

Table No. 40  
(As per the 2003-04)

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<th>Sl. No.</th>
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<th>No. of Talukas</th>
<th>Name of the Talukas</th>
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<tr>
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<td>Very Low 7.0 &amp; below</td>
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<td>Aurad, Kadur, Madhugiri, Sringeri, Hubballi, Kundagoli, Gadag, Chincholi, Chitrapur, Gulbarga, Jewargi, Sedum, Yadagiri, Shiggaon, Madakeri</td>
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Karnataka
District wise area under
Irrigation, in thousand hectares
2003-2004

INDEX in hectares
* More than 200
150 to 200
100 to 150
50 to 100
Below 50

Fig. No. 8
Karnataka State
Different Sources of Irrigation in Percentage
(Area in hectares)
As per the data 2003-04

- Other Source Irrigation, 10.36% 258178 hectares
- Lift Irrigation, 3.94% 99215 hectares
- Canal Irrigation, 38.20% 952021 hectares
- Borewell Irrigation, 18.04% 449674 hectares
- Tank Irrigation, 10.23% 254965 hectares
- Well Irrigation, 19.21% 478818 hectares

Fig. No. 9
irrigation. The four taluks of Cauvery river basin i.e. T.Narasipur (70.85%), Kollegal (63.55%), Malavalli (52.16%) and Maddur (51.89%) get water for irrigation from Cauvery river dam and its tributary dams.

Medium Range: In this group 44 taluks are observed. The extent of irrigation in these taluks is from 28.4% to 49.7%. These taluks are found in bunches spread in south east, south, west, central east and north west of Karnataka. These taluks belong to river systems of Krishna, Tungabhadra and Cauvery. Some taluks of the medium range irrigation also belong to high rainfall zone of Karnataka i.e. Kodagu taluk, Mulabagil taluk of Kolar district has as low as 28.08% while maximum irrigation is observed in Nargund taluk with 49.24%.

The low range of irrigation is observed in 87 taluks which are well distributed in most of the part of Karnataka while among 87 taluks it is found in only 4 taluks of western ghats. The maximum percentage of irrigation is found in Bangalore east taluk with 28.94% area under irrigation. Out of 87 taluks more than 70 taluks appear in the dry zone i.e. in rain shadow region of Karnataka. The lowest irrigated area being 7.11% is observed in Aland taluk of Bidar district, where due to less rainfall not only the surface water is less but also the underground water. Therefore all these 87 taluks need watershed management programmes so as to increase / recharge underground water system. Very low range of irrigation: In this category 15 taluks are observed where the percentage of irrigated land is below 7%. These taluks are found in Gulbarga district, Bidar district, Dharwad district, Gadag district, Haveri district, Chikkamangalore district and Kodagu district.

Intensity of Irrigation: The intensity of irrigation* is done by using the formula:

\[
\text{Intensity} = \frac{\text{Gross irrigated area}}{\text{Net irrigated area}} \times 100
\]

Where

- Gross irrigated area = Net area irrigated + area irrigated more than once since data on “area irrigated more than once is not available and therefore it is assured that area sown more than once is because of irrigation made on such land and hence in place of “area irrigated more than once” “area sown more than once” is taken into account.

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<tr>
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TALUKAWISE INTENSITY OF IRRIGATION
(Range in Percent)
As per the data of 2003-04

Fig. No. 10
A taluk having even less than one percentage of sown area under irrigation can appear as "very high intensity" taluk under the study of "intensity of irrigation", mainly because of considering the "area sown more than once" as a part of irrigated area as per formula used. In such situation the annual rainfall has favoured the farmers to cultivate more than one crop and consequently as per the formula adopted, such taluks (low area under irrigation) appears as "very high under intensity of irrigation" (examples like Kundagol 0.57%, Hubli 4.12%, Dharwad 7.76%, Savanur 8.02% and Shiggaoa 4.29%), contrary to this situation the taluks having very highly irrigated or more irrigated appear as "low intensity" mainly because of cropping pattern where single crop like Sugarcane/plantation agriculture crops occupy as one crop under 'area sown more than once'. Hence such taluks do not show more area as "sown area more than once" and thus more irrigated/high irrigated taluks/moderately irrigated taluks appear as "low intensity of irrigation/medium intensity of irrigation".

Development of Irrigation

At present (during 2003-04), the Karnataka state has nearly 24.94 lakh hectares of land under irrigation. The progress could not be viewed satisfactory as: (i) it so far covers only about a fifth of the cropped area, and (ii) nearly two-thirds of the available resource potential remains undeveloped. For want of irrigation, droughts continue to take a heavy toll on crops in 80 per cent of the cropped area and a second or a third crop cannot be raised during the year in 87 per cent of it. Paucity of irrigation is mainly responsible for the low performance of the new technology in 80 per cent of the cropped area. Irrigation is essential for a successful harvest in view of the low (below 75 cm) and highly erratic rainfall in the eastern two-thirds of the Karnataka state and almost no rainfall in three-fourths of the year (from October to May) over the whole state.

Irrigation Potential

The ultimate potential for irrigation in the state is estimated at 55 lakh hectares including 35 lakh hectares from major and medium projects and 10 lakh hectares each from minor surface schemes and groundwater. The state so far has a developed provision of only 25 lakh hectares, i.e., about 45 per cent of the total available potential. The state hopes to develop this remaining potential fully by the year 2010 A.D. of course, these estimates are based on the prevailing requirement of about 0.8 hectare-metre per hectare, which includes significant conveyance losses and excessive use, which are likely to decline in the coming years with improvement in
conveyance channels and irrigation techniques. The state's irrigation resources can be significantly augmented by inter-basin transfer of water from water-surplus basins, specially from the west-flowing rivers in which water (58 per cent of the total) now simply flows as waste.

Source-wise Trends in Irrigated Area

Towards the end of the study period (2003-04) canals constituted the most important irrigation source with 41 per cent of the net irrigated area and wells came next with 25 per cent, while other sources including also lift irrigation and bore-wells had 20 per cent and tanks only 14 per cent. Tanks had the largest area under irrigation (40 per cent of net irrigated area) in 1960-61 and canals came a distant second with 27 per cent. The decline in tank irrigated area is attributable mainly to the reduction in their storage capacity as most tanks have silted up and their veirs, some of which are very old, have collapsed for want of repairs. The funds granted by the government for tank maintenance are grossly inadequate and the irrigation users also do not come forward to share the cost or work, thus allowing an enormous potential worth scores of major schemes, to go to waste—a major failure of the Karnataka state.

Well-irrigated area in the state with its share in the net irrigated area rising from only 16 per cent in 1960-61 to 25 per cent in 1987-90, is the second most important source. Well-irrigated area made a rapid progress after 1965-66 due to provision of loan facilities for well-construction, subsidies on irrigation pumps and free power to pumps below 10 HP capacity, which mostly they are. Introduction of the bore-well technology opened an altogether new chapter in groundwater use for irrigation, the number of bore-wells increasing from only 585 in 1980-81 to about 60,000 in 1990-91 and bore-well irrigated area rising from a mere 762 hectares in 1980-81 to 1.94 lakh hectares in 1987-90.

For obvious reasons, canal irrigation remains the most unevenly distributed source in the state with Bellary, Raichur, Belgaum, Bijapur, Dharwad, Gulbarga, Shimoga, Chitradurga, Mandya and Mysore together accounting for 88 per cent of the total canal irrigated area, which in fact is confined mostly to the command areas of the projects of the Krishna and Cauvery basins. There is very little of canal irrigation outside these basins in Uttar and Dakshin Kannada, and Bidar districts. Even in these basins, the high inter-fluve zones between all major rivers have little of canal irrigation in Kodagu, Bangalore, Kolar and Tumkur districts.
Tank irrigation is still significant in several taluks of the South Maidan and Malnad regions and in the Uttar Kannada district of the coastal region, where the other sources have not made much head way so far. Well irrigation is important in the North Maidan and South Maidan regions and in the Dakshin Kannada district of the coastal region. Bore-wells irrigated area has sharply increased in several South and North Maidan districts, especially in Bangalore, Chitradurga, Kolar, Dharwad and Belgaum, where due to excessive drawings the groundwater level has fallen to a critical depth. There is need to control the sinking of bore-wells beyond a minimum horizontal distance of an existing one and upto a maximum depth to prevent this adverse trend.

Lift irrigation has emerged as an important irrigation source among the other sources in recent years. Lift irrigated area rose from only 30,000 hectares in 1980-81 to 1.17 lakh hectare in 1987-90. Most of these schemes, involving pumping of water from rivers in the North Maidan, have come up under initiative of individual or groups of farmers, in some larger schemes even by co-operative societies. As their construction and operation is by the users themselves, they are cost-effective and efficient involving very little of wastage or misuse.

Inequity in irrigated area is responsible for the disparity in agricultural development in the state. **Low irrigation development in low rainfall areas, specially in Bijapur, Dharwad and Gulbarga districts, to some extent even in Bidar, is responsible for low crop yield and low cropping intensity.**

### Undeveloped Potential of Irrigation

The Karnataka state still has 5,077 million cu m of uncommitted potential as per its master plans for the utilisation of which schemes should be formulated and executed expeditiously. It should also make an all out effort to receive as early as possible, the 651 million cu m of water resources by way of the Godavari diversion, awarded by the Godavari Tribunal. Implementation of scheme ‘B’ of the Krishna Tribunal Award can further add 5,180 million cu m to its resources.

### Diversion of Rivers

The problem of water deficiency in the eastern and central parts of the state can be ultimately solved only through a transfer from the other surplus areas. Diversion of water from the West-flowing rivers of the Sahyadris, which now carry 58 per cent of the surface flow as waste to the Arabian Sea, and the Godavari-Krishna-Penner Link of the Ganga-Cauvery Link Canal as suggested earlier by Rao
(1979) and now in greater detail by the NWDA with an allocation of 6116 million cu m under its PRWD schemes (Government of Karnataka, 1992) are two such schemes for the implementation of which the government should address itself for meeting adequately the present and even future demand for water in the state.

Policy Implications

Lack of funds has been the chief reason for the delay in the completion of irrigation projects in the Karnataka state after Independence. As the number of such schemes were too many and the funds available for the purpose (out of state plans based on revenue surpluses, loans from the public, loans and grants from the Union Government and of late, loans from the World Bank) were inadequate, the work had to be extended and this led to escalation of costs due to increased interest liability and price rise.

A serious flaw in the present policy of funding major/medium irrigation in the drought-prone areas in India (to which category most schemes in Karnataka belong) is that these are treated as a ‘welfare measure’ and undertaken to ameliorate widespread suffering and to provide protection against recurrent failure of crops (Government of India, 1972). Construction of these projects, as a result, has become a government responsibility exclusively and even after their completion what the irrigators pay as water rates are not enough even to meet their maintenance cost. Whereas all the irrigation projects in the country made a substantial revenue contribution before Independence, recurrent and increasing losses have been a common feature since then, as the new schemes are all far more costlier in construction and the water rates remain a pittance (Government of India, 1972). Indeed in no other sector of government intervention are such extensive outlays committed in support of such low returns, thus throwing open the question of whether investment in major and medium irrigation is productive and a catalyst for growth (Government of Karnataka, 1985). This is despite the fact that water from all such projects has been used for productive purpose-intensive cropping with massive expansion of area under heavy duty crops like paddy and sugarcane (Government of India, 1981).

Time has come indeed, to revamp the policy and to make the irrigators pay for the benefits that accrue to them from irrigation from canals. They should be made to pay for at least a part of the cost of civil works and water rates charged (from them) should be based on a cost-benefit ratio. The maintenance cess, for which provision was made by the government in 1972, has not been collected, though its legitimacy
has never been in doubt and if collected, it would have substantially improved the financial position of the state. Time has come to review the position. Water supply to farms should be made volumetric and distribution according to rotation or warabandi system, which measures would not only generate more revenue and ensure irrigation water to a larger area and more crops in a fair manner, but will also put an effective check on the indiscriminate expansion of the cultivation of moisture intensive crops and reduce the problem of waterlogging, salinity and alkalinity of soils, which now affect extensive tracts in the commands of several major/medium projects, specially in the black soil tracts of the Tungabhadra and Bhadra projects.

Suitable adjustments in the cropping patterns and improvements in irrigation techniques can bring about a lot of efficiency and save substantial loss of water. There is need to effect these changes, particularly in the irrigation of paddy and sugarcane, which crops with only about 12 per cent of the total cropped area consume more than 40 per cent of irrigation water. They require 3-4 times the water needed for irrigating crops like jowar or ragi (Government of India, 1979). Excessive cultivation of paddy and sugarcane in salt-rich soils has often led to the problems of waterlogging, salinity and alkalinity in the command of the Tungabhadra Left Bank Canal.

Tanks

Embanked tanks are an integral part of the rural landscape of Karnataka. They formed till recently, an extremely important irrigation source in the state. In spite of a decline in their number in recent years, Karnataka still has about 36,000 tanks, their ayacut size varying from a few to over 500 hectares. Most large tanks were built by rulers, chieftains, rich merchants, or religious men as charity works in the distant past. They are often called sagara or lakes. The Shantisagara tank near Channagiri (Shimoga) for example, has a water spread of 41 sq km and the Watadahosahalli tank near Gudibanda (Kolar) irrigates nearly 1,000 hectares. Such large tanks are, however, only few in number and more than 90 per cent are small units with less than 40 hectares ayacuts, 16,400 have an ayacut of less than four hectares each.

Tanks have been constructed mostly across small seasonal streams, though many have a catchment just on a high ground. A series of tanks have been constructed one below the other, across the same stream in some cases. The Palar river, for example, has 999 such tanks above the Ramasagara tank in Kolar district. Surplus water flowing from a tank in such cases feeds the one below it and the latter a third
one down the valley in succession. Tanks in the upper course are much smaller and intended often only as check dams to prevent soil erosion in the catchment above them and inflow of silt into the tanks below.

Regional Trends in Tank Irrigation

Whereas tanks are a common feature of all parts of Karnataka, the L-shaped tract covering partly or fully the districts of Kolar, Bangalore, Tumkur, Hassan, Chikmagalur, Shimoga, Dharwad, and Uttar Kannada, has a greater concentration with more than 30,000 units and two-thirds of the state’s total tank ayacut. Tank construction and irrigation represent an ingenious human response to the environment of these South Maidan and Malnad districts. Rugged relief and a rainfall regime with a significant winter component render tanks a feasible proposition in this zone. At the same time, its hard rocks, poor difficult-to-locate groundwater aquifers and rugged relief pose problems for digging wells or canals leaving tanks as the only viable alternative.

Restoration of Tanks

As the damage in many cases is extensive, considerable investments will be needed for the restoration of tanks. The required finance should, for this purpose, be shared, therefore, by the government, the farmers benefiting from tanks and if need be raised as loans from financial institutions. The government, in fact, should encourage for this purpose, the formation of tank irrigation co-operatives similar to the Mohini Water Co-operative Society in the command area of the Kakrapar Weir and Canal Project of Gujarat and the ‘Sinchai Panchayats’ in the Tawa Project of Madhya Pradesh. The ‘phatf system of north-western Maharashtra (Tapi basin) will, similarly be ideal for an equitable and need-based distribution of water from tanks below the main outlet, a source of many-a-dispute at present (Dikshit et al, 1993). The key role, it should be noted, in all these schemes, is played by the beneficiary farmers and the government’s involvement is confined to only providing the necessary guidelines. The co-operatives / panchayats decide how water is to be distributed, what crops are to be raised, and what charges on water are to be levied.

The restoration work should not be confined to the desilting of tanks and repair of tank bunds but it should cover the planning and development of the whole water sheds. Check dams and percolation ponds should be constructed and all the non-arable lands in the catchment areas should be afforested to prevent soil erosion, which causes the silting up of tanks. Tank bunds should be turfed and irrigation
channels should be lined to prevent damage to bunds and water seepage. Development of fisheries should be encouraged in the tanks to raise revenue that can be used for maintenance. Tanks are a boon to their ayacuts not only because they provide the much needed water for irrigation and can be used for pisciculture, but also as they recharge the water-table and render wells in the area more dependable a source of water supply and thus ensure a more balanced and sustainable ecological balance.

**Groundwater Resources**

Though Karnataka’s groundwater aquifers are not as rich as, for example, of the plains of Punjab or Uttar Pradesh, they are not insignificant and are spatially well distributed. These dynamic, seasonally renewable resources occur all over the state in the mantle of loose soil and decomposed rocks below, ranging from a thin film of a few metres to 30 metres. The water availability in this seasonally recharged, saturated zone is of course only limited (0.25-3.0 gallons per cubic foot) and fluctuant. In wells dug into this zone, the level falls rapidly after rains reaching the lowest level in March-April, when a large number fails. The water table in the state fluctuates by 2.5-3 metres, though in the hilly terrain and in deeper, decomposed pockets, the difference could be as much as 18-24 metres (Government of India, 1972). The occurrence, behaviour and movement of the static groundwater in the deeper, more complex, hard crystalline and non-crystalline rocks, however, is not understood sufficiently as a detailed geo-hydrological survey of the state has not been carried out so far, though the groundwater cell in its Department of Mines and Geology has been in existence now for over 25 years. So far, the cell has completed only a first generation survey based on a large number of observation wells, which has, of course, helped in identifying the broad hydrological features and made possible the tapping of groundwater in the shallow zones through dug and borewells.

A preliminary assessment of groundwater potential in the state based on the assumption that about 8-10 per cent of the rain water percolates underground indicates that about 18,500 million cu m of water goes to recharge the underground aquifers (Government of India, 1972). However, only about 50 per cent of this potential is utilisable economically. Assuming that about 0.8 to 1 cu m of water is required to irrigate one hectare of land annually Karnataka’s groundwater resources are sufficient to cover about 10 lakh hectares with assured irrigation.
Wells and Well-Irrigated Area: An open well in the state irrigating one to 1.5 hectares of land, the existing groundwater potential provides scope for 6 to 10 lakh wells. The present number of 4.5 lakh wells and 5 lakh hectares of well-irrigated area, therefore, leaves a scope for 80-100 per cent expansion. Most of the wells in the state at present are open wells with a depth of 12-15 metres, and the number of borewells tapping water from deeper, basement aquifers and irrigating a larger area, is so far small, though it is increasing at a fast rate. The number of open wells has also gone up sharply due to several favourable factors including easy availability of loans from the government (takkavi) and financial institutions, subsidies on lift machines, mostly free power supply, and above all an acute urge with the farmer to have his own irrigation sources, which has emerged as a key factor in the success of modern agricultural technology. Frequent droughts have provided an additional compulsion.

Wells are a very important source of irrigation in the drought-prone North and South Maidan and in the coastal district of Dakshin Kannada. Well-irrigation is often associated with garden crops and areas lacking surface irrigation. Almost the entire irrigation development is based on wells in the whole of Bidar district and in large parts of Bijapur district (Bagalkot, Basawan Bagewadi, Bijapur, and Sindgi taluks), Gulbarga district (Afzalpur, Aland and Gulbarga taluks), Raichur district (Kushtagi and Yelburga taluks), Bellary district (Kudligi taluk) and Mysore district (Gundlupet and Kollegal taluks). In 35 other taluks lying in the Maidan and coastal regions, wells are the most important source of irrigation.

The green revolution period since 1966-67, has seen more than a doubling of the well-irrigated area in the state (from 2.27 lakh hectares to 5.03 lakh hectares). The rising trend was also universal spatially and its extent phenomenal in several districts more than nine times in Mysore, four times in Uttar Kannada, Raichur and Bellary, and three times in Bijapur, Dharwad, and Shimoga. Despite a rapid growth, the proportion of well-irrigated area has fallen in several districts due to higher growth in other sources like canals, lift-irrigation and bore-wells.

Bore-Wells: Exploitation of groundwater has taken a quantum jump with the introduction of the borewell technology in the recent years. Such wells (of 10-20 cm diameter) tap water from much deeper (45-100 m) aquifers and yield a much larger quantity of water than open-wells. A bore-well can perennially irrigate upto 5 hectares of land depending on the richness of the tapped aquifers. The total number of bore-wells in the state has gone up to 60,000 and the area irrigated by bore-wells to 1.29 lakh hectares. The South Maidan has the largest concentration of bore-well irrigated area (56 per cent) and most of the remaining is in the North Maidan (40 per cent).
Malnad and the Coastal regions have only a small portion (3 per cent and 1 per cent respectively) of the total bore-well irrigated area in the state. Bore-wells have emerged as an important irrigation source in Kolar, Chitradurga and Bangalore districts with 33 per cent, 19 per cent and 17 per cent respectively of the net irrigated area; Belgaum and Tumkur follow with 8 per cent and 7 per cent respectively and Bellary and Chikmagalur have 5 per cent and 4 per cent respectively.

The Bailhongal taluk of Belgaum district; Chitradurga and Holalkere taluks of Chitradurga district; Byadgi, Ron and Savanur taluks of Dharwad district; and Gauribidnur and Malur taluks of Kolar district have more than 50 per cent of the net irrigated are under bore-wells.

**Problems of Groundwater Development**

Development of groundwater in the cases of both wells and bore-wells involves peculiar problems. Striking groundwater in the state’s crystalline rocks, unlike in the Indo-Gangetic plains, is not easy everywhere and involves considerable risk, specially in the case of bore-wells. Groundwater occurs in seams, the exact location of which cannot be easily determined. Also any well sunk here has to be excavated in hard rock up to at least some depth and diameter of an open well has to be wider, which factors render well construction a costly proposition. Most wells being open unlined type, their sides often collapse rendering them unusable.

**Table No. 42  Ground water Recharge and Utilisation**

<table>
<thead>
<tr>
<th>Districts</th>
<th>Net Annual Recharge ('000 ha m)</th>
<th>Net Annual Utilization ('000 ha m)</th>
<th>Net Annual Utilization (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangalore</td>
<td>76.46</td>
<td>64.17</td>
<td>84</td>
</tr>
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<td>Belgaum</td>
<td>100.64</td>
<td>65.00</td>
<td>65</td>
</tr>
<tr>
<td>Bellary</td>
<td>73.77</td>
<td>20.99</td>
<td>28</td>
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<tr>
<td>Bidar</td>
<td>43.36</td>
<td>20.07</td>
<td>46</td>
</tr>
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<td>Bijapur</td>
<td>93.57</td>
<td>54.44</td>
<td>58</td>
</tr>
<tr>
<td>Chikmagalur</td>
<td>65.25</td>
<td>6.64</td>
<td>10</td>
</tr>
<tr>
<td>Chitradurga</td>
<td>59.83</td>
<td>34.24</td>
<td>57</td>
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<tr>
<td>D.Kannada</td>
<td>101.07</td>
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</tr>
<tr>
<td>Dharwad</td>
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<tr>
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</tr>
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<td>Hassan</td>
<td>65.50</td>
<td>10.42</td>
<td>16</td>
</tr>
<tr>
<td>Kodagu</td>
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<td>6</td>
</tr>
<tr>
<td>Kolar</td>
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<td>94</td>
</tr>
<tr>
<td>Mandyaya</td>
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<td>Mysore</td>
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</tr>
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<td>Raichur</td>
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<tr>
<td>Shimoga</td>
<td>134.43</td>
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<td>9</td>
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<tr>
<td>Tumkur</td>
<td>84.27</td>
<td>55.69</td>
<td>66</td>
</tr>
<tr>
<td>U.Kannada</td>
<td>89.51</td>
<td>10.95</td>
<td>12</td>
</tr>
</tbody>
</table>

A drastic fall in the water-table due to too many bore-wells, is yet another serious problem in some areas. As the table above shows the situation has already reached a critical level in several districts. In 17 taluks the exploitation level exceeds 85 per cent and it is about to reach this limit in 22 other taluks with far reaching consequences. Of these 39 taluks, 9 are in Bangalore district, 10 in Kolar district, 6 in Tumkur district and 5 in Belgaum district (Basappa Reddy et al, 1992). Too many bore-wells too close to one another are depleting the groundwater resources and creating a diseconomy for farmers, whose bore-wells go dry, and this is happening despite a statutory provision in the state for controlling the sinking of bore-wells and wells.

More or less free power supply and subsidy on all types of lift machinery used in well and bore-well irrigation has encouraged indiscriminate sinking of bore-wells in many, specially Maidan districts and time has come, therefore, to review this policy. It is essential to prevent sinking of bore-wells beyond a certain depth and within a minimum horizontal distance of an existing bore-well or well. On the contrary, there is need to promote well irrigation near canals, specially in the North Maidan's black soil tracts to prevent waterlogging and alkalinity and salinity of soils and also in other districts, where the exploitation so far is small.

Other Sources

Other than canals, wells and tanks, several other contrivances are also used for irrigation by farmers in Karnataka. These other methods depend mainly on locally available surface water resources in an area and the extent of development of the sources like canals, wells and tanks. The capacity of these other methods is very small in most cases. Streams and springs, which are perennial or continue to flow for long even after the rains have ceased, enable farmers to raise two or even three crops during the year in most parts of the Malnad and coastal regions. Other sources are a predominant source of irrigation in all taluks of Dakshin Kannada (with nearly 60 per cent of the net irrigated area in the district and in all taluks, except Sullia which has 42 per cent). All the coastal taluks and Supa in the interior of Uttar Kannada district, have 43-66 per cent of the net irrigated area under other-sources, tanks gaining importance in the drier eastern parts of the district. The Uttar Kannada district has about 36 per cent of its irrigated area under such sources. In Chikmagalur district, where other sources have about 26 per cent of the net irrigated area, almost the entire irrigation (95 per cent) depends on the other sources in Sringeri taluk, while Mudigere
and Koppa have 69 per cent and 53 per cent respectively. The Madikeri and Virajpet taluks with 64 per cent and 35 per cent respectively of the net irrigated area contribute most of the other sources' irrigated area in Kodagu, it forming 21 per cent of the net irrigated area of the district. Other sources have 47 per cent of the net irrigated area in the hilly Sakleshpur taluk of Hassan district.

In the drier North Maidan with a poor irrigation development, other sources are mainly in the form of diversion of river channels with low, temporary earthen bunds and their contribution is specially important in Bijapur and Dharwad districts with 22 per cent and 16 per cent respectively of the net irrigated area. In the former district, a larger area (20-40 per cent of the net irrigated area) is under such sources in the western and southern taluks of Jamkhandi, Mudhol, Bilgi, Badami, Hungund and Muddebihal, through which the Krishna, Ghataprabha and Malaprabha rivers flow. In Dharwad district, Haveri, Ranebennur, Mundargi and Navalgund have a significant net irrigated area proportion (20-40 per cent) under other sources.

The state had 1.33 lakh hectares of area irrigated by other sources in 1966-69, which rose to 1.58 lakh hectares in 1987-90 indicating a 19 per cent increase. The positive trend was recorded in many districts, it being very spectacular (87 times) in Bijapur, where except Hungund and Badami, all the other taluks had a rising trend. Raichur district had a seven times rise due to a sharp increase in Raichur taluk. Other sources' area also nearly doubled in Uttar Kannada district. The increase was marginal in Bellary, Dakshin Kannada, and Mandya, whereas Chikmagalur, Hassan, Kodagu, Shimoga, Mysore, Bangalore, Belgaum, Bidar and Gulbarga had a decline. In Chitradurga, Kolar and Tumkur, this area was considerable.

Lift Irrigation

Lift irrigation involving pumping of water from streams and reservoirs has assumed a lot of significance in the irrigation system of Karnataka in recent years. The method is very successful in areas, where extensive cropped area remains un-irrigated on high river banks up to 20 metres, as for example, in the case of the Krishna river valley. Lift irrigation is an important part of several major/medium irrigation schemes in the state and the Hippargi Barrage in Bijapur district is a major lift irrigation scheme.

Only about 400 such schemes were reported in the state till recently and all included in the other sources, were constructed by the government and under control of the Minor Irrigation Dept. and Zilla Parishads. Their number since then has shot up
to nearly 26,000 and the area irrigated by them has risen from only 30,000 hectares in 1980-83 to over 87,500 hectares currently. Most of these schemes have come up under initiative of individual farmers or co-operatives of farmers. They are mostly very small, irrigating only a few hectares each, but some, specially those built by the government and sugar mill co-operatives have often a command of several hundred hectares—a few even exceeding one thousand hectares.

During the last few years lift irrigation has emerged as an important source in some areas of specially Belgaum district, which currently has 76,000 hectares or 32 per cent of the net irrigated area under lift irrigation giving this source the prime position among all sources of irrigation. The district has 65 per cent of the total lift irrigated area in the state. All the ten taluks of this district have a large area under lift irrigation and over 50 per cent of net irrigated area in Athani and Hukkeri taluks and 41-45 percent in Chikodi, Khanapur and Soundatti is lift irrigated. The method has also gained importance in Bellary district, which now has about 8 per cent of the net irrigated area under lift irrigation, most of it in Hadagalli taluk. In Bijapur district, where all the present 36 schemes were built by the government, Bagalkot taluk has a large area served by lifts. Several new schemes are coming up in the district as co-operative ventures. The Chikkapadasalagi and Hegur barrages on the Krishna river in Bilgi taluk are important amongst these. The Ranebennur, Hirekerur and Mundargi taluks of Dharwad district have 10-15 per cent of the net irrigated area under lift irrigation. The Jevargi taluk of Gulbarga district, Koppal taluk of Raichur district and Holenarsipur taluk of Shimoga district have a large area (up to 20 per cent of net irrigated area) under lift irrigation. The Harihar taluk of Chitradurga district and Kundapur and Karkal taluks of Dakshin Kannada district have a large area under lift irrigation.

Chief advantages of the lift irrigation schemes are their higher operational efficiency and cost effectiveness. Their success, however, depends on co-operation from the farmers, which is not always forthcoming, and uninterrupted power supply required for the lift pumps, which is also not satisfactory due to extreme shortages and cuts. The State Government set up in 1986, two Lift Irrigation Corporations, one each for the Krishna and Cauvery basins with a provision of participatory funding by the farmers (15 per cent), government (10 per cent), and loans from scheduled banks (75 per cent). The scheme fell through for want of response from the farmers. The movement in fact is so far important in only Belgaum district and to some extent in
Bijapur district. Almost everywhere else, the lift schemes are mostly government built and managed.

A serious flaw in the lift irrigation schemes in Belgaum district and also in some other areas, is their use solely for raising high water duty crops like sugarcane and paddy, which may lead to the by now familiar problems of waterlogging, salinity and alkalinity, specially in the black soil tracts. Also many schemes are erected in an unauthorised manner. Whereas it appears economically sound to permit lift irrigation in all the areas, where extensive croplands on high river banks remain unirrigated, it would be necessary to enact suitable legislation and carefully plan lift irrigation development basin-wise.

There is need for a larger irrigation coverage also in the higher rainfall Malnad and coastal regions during the dry weather from October to May for a rabi/summer crop and also during the rainy season as a stand-by measure to combat moisture stress during dry spells in the case specially of rice, a highly moisture intensive crop, which is heavily concentrated here. The development so far is very inadequate. Less than 10 per cent of the net sown area is irrigated in Madikeri and Virajpet taluks of Kodagu district; Hassan taluk of Hassan district; and Sirsi and Karwar taluks of Uttar Kannada district.

Consequences of Inadequate Coverage

Deficiency of irrigation clearly reflects in all important spheres of agriculture in the state including agricultural landuse, cropping intensity, cropping patterns and crop yields. Only about 56 per cent of the reporting area is net sown in Karnataka compared to 82 and 83 per cent respectively in Haryana and Punjab, where 83 per cent and 92 per cent respectively of the cropped area is covered with assured irrigation compared to Karnataka's 21 per cent. The unusually high incidence of fallowing in the North Maidan, specially Gulbarga division, is ascribable mainly to lack of irrigation. Farmers have to often resort to fallowing all over the North and South Maidan in the years, when the onset of the monsoons is delayed or if they are weak and reduction in fallow lands in recent years is due to an expansion in the irrigation facilities in these areas.

Irrigation is essential in the state for raising crops in dry weather from October to May. The low intensity of cropping (raising more than one crop during the year in a sequence on the same farm) in the state, 113 per cent, when compared to 126 per cent in India as a whole and 156 per cent and 172 per cent respectively in Haryana and
Punjab is yet another adverse consequence of the state’s poor irrigation development. More than 85 taluks have a below average intensity and most of these lie in the Maidan or Malnad regions with the lowest irrigation development. There is, in fact, a high degree of positive correlation between the extent of irrigation and cropping intensity all through the state.

The impact of irrigation deficiency is clearly manifest in the state’s cropping patterns with more than 80 per cent of the cropped area being under rainfed crops including coarse cereals, pulses and oilseeds. Such crops virtually sum up the entire pattern in many taluks. Predominantly irrigated crops including rice, maize, sugarcane and hybrid cotton occupy only 18 per cent of the cropped area. Karnataka has substantially high yields in all the irrigated crops—the highest in India in maize and sugarcane. Such crops, however, occupy only a small area and over four-fifths of the cropped area in the state is under the low yield coarse cereals, pulses and oil seeds, which are grown mainly rainfed and whose cultivation is often neglected by farmers. These crops also lack suitable high-yielding varieties.

**Thrust of the Research**

The ultimate potential for irrigation in the Karnataka state is estimated to be 55 lakh hectares which includes 35 lakh hectares from major and medium river projects, 10 lakh hectares from minor surface projects and another 10 lakh hectares from underground water. The Karnataka state so far has developed only 25 lakh hectares of area under irrigation which is only 45% of the total available potential. The deficiency of water for the irrigation in the eastern and central parts of Karnataka can be solved through transfer of water from other surplus areas. In this regard the diversion of water from the west flowing rivers of Karnataka can be of best use. The methods like rain harvesting, watershed management, soil bunding and adoption of scientific methods in irrigation management can improve the status of irrigation in the North and South Maidan region of Karnataka, where nearly 102 taluks at present are showing only 1% to 28% area under irrigation. As a result of which the intensity of cropping, high yields of crops, quality of crops and need based agricultural production can be possible in Karnataka and thereby green revolution in Karnataka to a maximum possible extent can be achieved.