

Exploiting Hydel Power Potential to Maintain Energy and Water Securities in Kerala

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ABSTRACT

Demands in energy have been increasing tremendously in the state of Kerala in India, associated with rise in population, changing climate, rapid urbanization, industrialisation and the changing life styles. This heavy rainfall region that depends on cheap hydroelectric power for most of its energy needs has not yet fully utilised the water potential. Shortage of power leads to conflicts over allocation and timing of supply. There are limitation for large projects due to geological and geographical factors and also uncertainties in climate. There are options for maximum utilisation of available sources including conversion of existing dams multipurpose, modernisation of machinery, and construction of more mini hydel power plants. This will also solve issues related to water shortage that is the result of inadequate conservation and management practices. The State lacks an appropriate policy for energy and water. This paper analyses the various issues associated with power and water crisis and explores the possibilities of sustainable exploitation of hydel power in Kerala.

1 INTRODUCTION

Kerala is a small state, tucked away in the southwest corner of India. It represents only 1.18% of the total area of India but 3.43% of the total population of the country lives here. The population of Kerala as on 1st March 2001 stood at 31,838,619 as per the provisional results of the Census of India 2001. While all India decadal growth rate of population during 1991-2001 was 21.34%, in Kerala this has further dipped to 9.42% from 14.32% during 1981-1991 (Government of India, 2001). Though growth rate is small, impact of this increasing population on the environment is tremendous.

1.1 Topography and Rainfall

Based on the topography, the State can be divided into (Fig. 1) three well-defined natural divisions. a) The eastern highlands - hilly region sloping down from the western side of the Western Ghats with dense forests and small streams. Though area under this division is the largest, density of population is small. This is a heavy rainfall region (250 to 500cm from south to north). All rivers originate here and flow fast westwards to the Sea. Height of the steep mountains ranges from 75m to 2km, with an average of 900M. b) The midlands - the central plain lying between the mountains and the lowlands. This region is made up of undulating hills and valleys and is intersected by a number of rivers. Its elevation ranges from 8 to 75m. Rainfall in this region varies from 200 to 400cm, from south to north. c) The lowlands - the coastal area made up of the river deltas, backwaters and shore of the Arabian Sea. There exists a continuous chain of lagoons and backwaters along the coastline. They are interconnected by natural and man-made canals and are connected to the Sea through small openings. This area has a height less than 8m and an area of 3979km². Though the area is only about 10% of the State, major cities are located here and 25% of the population lives here. North-south variation of rainfall is 200to 350cm. Orography of the Western Ghats produces an average rainfall of more than 300cm in the State, 270cm of which falls during June - December. Northern parts of the State receive most of the rainfall from the southwest monsoon whereas

the northeast monsoon is pronounced only in the southernmost parts. Intensity of rainfall ranges from around 2cm/rainy day in the southern districts to around 3cm/rainy day in the north.

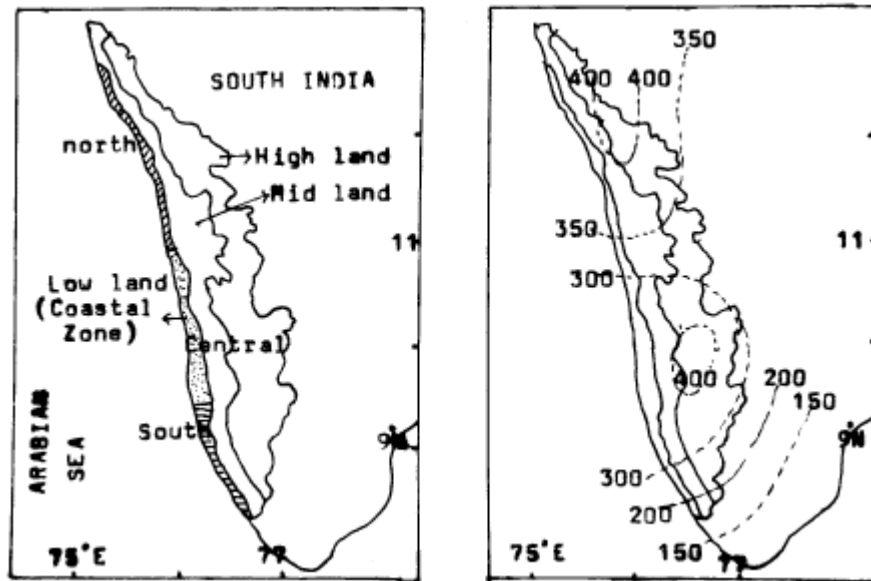


Fig. 1 Kerala – Geography and rainfall

1.2 Water Resources

The State is rich in water resources, with 44 rivers and their tributaries and other freshwater bodies (Table 1). These rivers have an average length of 80Km and a watershed of 700Km². Rivers of Kerala are comparatively small and being entirely monsoon-fed, some of them practically turn into rivulets in summer, especially in the upper areas. In spite of the heavy rainfall and numerous water resources, Kerala faces serious water shortages on certain occasions leading to power crisis, as a result of irregularities in temporal and spatial distribution of rainfall, slope of the terrain and improper water resources management and conservation measures.

More than the fluctuations in total amount, it is the temporal variations in the rainfall that affects the water availability of a region (Walsh & Lawler, 1981). Kerala experienced less serious water shortages in the years with good pre-monsoon rainfall from local systems compared to heavy and highly seasonal rainfall years. For rain-fed agriculture and domestic water requirements, a less seasonal rainfall is more favourable. Rainfall is highly seasonal in north Kerala because this region receives rainfall mainly from the southwest monsoon season. Northeast monsoon is also active in the south, owing to the peculiar topography of the Western Ghats.

Decadal changes in runoff and per capita water availability in the State (Table 2) were computed using the modified Water Balance model (Nair, 1987) and based on the guidelines suggested by GRDC (2000), in an altered climate (and also population in the case of per capita) by 2025, as predicted by climate models. The study reveals that the present annual per capita availability of the surplus water from precipitation for the State as a whole is 2503m³ whereas for India it is 2150m³, if fully utilised. By the year 2025, at the current rate of growth of population and with the predicted increase in global temperature, the availability will be drastically reduced to 1470m³. Seasonal water deficiencies show an increasing trend and the surpluses show a decreasing trend. In many parts, the per capita will be reduced to almost half the present level by the year 2025. Runoff is high in central Kerala because of large watersheds, and very low in the south, as the rainfall is low. In general, runoff does not show any annual trend and direct connections between runoff changes and global anomalies are not evident. However, due to local anomalies, monthly runoff in certain years has shown wide positive variations, depending on the intensity of rainfall. Such deviations were noticeable in 1924, 1933, 1946 and 1961(in the order of magnitude). Continuous and reliable measured runoff data of the rivers are not available for long period. Also, the available data are restricted and not easily accessible from Government agencies, as there exists serious dispute over sharing waters with the neighbouring States.

The only possible way to get runoff is by estimation. Estimates show that there has been a considerable reduction in the runoff in some rivers since the latter half of last century, because of the construction of dams and diversion of water. The inter basin transfer of water makes the estimation of runoff in rivers more difficult. There is no regular timing of release of water or the amount of water released from the dams. Deforestation at the upper reaches, sand quarrying in rivers and brick making in the riverbanks also affect the runoff in dry months. The once perennial rivulets connected to some of the rivers are becoming seasonal. Agriculture in the riverbeds during non-rainy months causes erosion in many places. Estimates show that a 0.5 degree increase in temperature may reduce the runoff from these rivers about 10-20%. According to WMO, rainfall increase may be very low in the study region, where the increase in precipitation may not be able to compensate for the reduction in soil moisture due to rise in temperature (Bhalme, 1997).

River	Length (Km)/ Catchment Area (Km ²)	Annual yield/ Utilisable yield (MCM)/ Irrigation Requirement (MCM)	River	Length (Km)/ Catchment Area (Km ²)	Annual yield/ Utilisable yield (MCM)/ Irrigation Requirement (MCM)
1.Manjeswar& 2.Uppala	16/90 50/76	309/106/149	23.Bharathapuzha	209/4400	6540/3349/4684
3.Shiriya	67/290	620/358/187	24.Keecheri& 25.Puzhakkal	51/401 29/234	1024/345/822
4.Moryal& 5.Chandragiri	34/132 105/570	1718/1218/507	26.Karuvannur	48/1054	1887/963/970
6.Chittari	25/145	- /-81	27.Chalakudy	130/1404	2591/1539/1093
7.Nileshwar& 8.Karingode	46/190 64/429	1356/937/329	28.Periyar	244/5284	11139/8004/1899
9.Kavvayi& 10.Peruvamba& 11.Ramapuram	31/143 51/300 19/52	1143/603/-	29.Muvattupuzha	121/1554	3814/18122/141
12.Kuppam	82/469	1236/786/2230	30.Meenachil	78/1272	2349/1110/1180
13.Valapattanam	110/1321	1784/1823/331	31.Manimala	90/847	829/1108/402
14.Anjarakkandy	48/412	986/503/89	32.Pamba	176/2235	4641/3164/1732
15.Tellicherry	28/132	251/122/81	33.Achenkovil	128/1484	2287/1249/889
16.Mahe	54/394	803/445/194	34.Pallikkal& 35.Kallada	42/220 121/1699	2270/1368/1162
17.Kuttyadi	74/583	1626/1015/352	36.Ithikkara	56/642	761/429/493
18.Korappuzha& 19.Kallayi& 20.Chaliyar& 21.Kadalundi	40/624 22/96 169/1535 130/1122	7135/2616/3541	37.Ayroom& 38.Vamanapuram& 39.Mamon	17/66 88/687 27/114	1324/889/755
22.Tirur	48/117	1165/60/221	40.Karamana	68/702	836/462/466
			41.Neyyar	56/497	433/229/502
			42.Kabani	-/1920	4333/4333/2182
			43.Bhavani	-/562	1019/1019/476
			44.Pambar	-/384	708/708/298

42, 43 and 44 are east flowing rivers

Table 1. Rivers of Kerala

Region	1901-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-00	Mean
South Kerala	407	421	456	407	351	400	386	400	316	372	392
Central Kerala	7398	8190	9247	9194	9828	9194	10568	9247	7767	8930	8956
North karalla	2840	2686	3009	3193	2993	2993	3224	2932	2563	2886	2932

RO – Mean annual runoff (Mm³)

Table 2. Decadal changes in runoff

2 CURRENT POWER SCENARIO

Hydropower development in Kerala started with the commissioning of Pallivasal Hydro Electric Project in 1940. Sabarigiri (1966) and Idukki (1976) were milestones in the power development in the State. There are 24 hydel Projects owned by KSEB and 2 by private agencies. The wind farm located at Kanjikkode with an installed capacity of 2.025 MW is the only one utilising the non-conventional energy source. The Brahmapuram and Kozhikode Diesel Power Plants with an installed capacity of 106.6 MW and 128 MW use LSHS as fuel and are owned by KSEB. The Kerala State Electricity Board has an installed capacity of 2087.23 MW on its own with another 570.016 MW contributed by NTPC and Private Sector producers taking the total installed capacity of State to 2657.24 MW (Table 3). The other plants that are catering to the energy demands of the state are the Kayamkulam plant of NTPC with an installed capacity of 359.58 MW and the BSES, Kochi Plant with an installed capacity of 157.00 MW. The 20.44 MW plant of KPCL, Kasaragod is the latest entrant in the IPP segment of generation. These plants are naphtha based. The balance is met through import of power from the Central Sector (KSEB, 2007).

The state has been trying to exploit the huge potential for generation of hydroelectricity, as it is non-polluting and inexpensive. Till recently, the larger part of the state's energy requirement was met by the hydro energy. Proclamation of the Forest Conservation Act 1980 has hampered the institution of new hydel power generation projects in the state. Only a fraction of the hydro power generation potential has been exploited thus far; of a power generation potential of about 4333 MW, only 1834 MW has been reined in.

Rising demands increased the state's dependency on thermal power, in spite of the high expenses incurred due to transportation of coal and the eco hazards faced in setting up and running this project. Kerala State Electricity Board was forced to set up two diesel power plants in the state at Brahmapuram near Kochi (106.6 MW) and at Kozhikode (128 MW). The Government of Kerala also acceded to the institution of the three Naphtha based thermal power plants. More thermal power also continues to be bought from the Central Generating Stations. The ratio of Thermal to Hydel power in the state stands at 66:34 as in 2003-2004.

Kerala Power System at a Glance: 2006	
Installed Capacity -M.W.	2644.25
Maximum Demand -M.W. (System)	2578
Generation Per Annum-M.U.	7600.78
Import Per Annum -M.U.	6700.50
Export Per Annum - M.U.	635.90
Energy Sales Per Annum-M.U.	10269.80
Energy losses (as % of energy available for sales)	24.59
Per capita Consumption- Kwh	427
No of Generating Stations	32
220 K.V. Lines- Circuit Km	2650
110 K.V. Lines- Circuit Km	3816
66 K.V. Lines- Circuit Km	2961
11 K.V Lines- Circuit Km	34680
LT. Lines- Circuit Km	215152
Step up Transformer Capacity -MVA	2391
No. of EHT Sub Stations	269
Step down Transformer Capacity -MVA	12508
Distribution- Transformers : a) Numbers	38193
b) Capacity - MVA	4947.77
No. of Villages Electrified (all)	1384
No. of consumers (in lakhs)	82.95
Connected Load -M.W.	10907.2
No. of Street lights	960839
No. of Irrigation Pumps	423571
Total Revenue per Annum (Rs. Lakhs)	383731.69
Sales of Power per annum	359011.49

Table 3. Kerala Power System (source: KSEB website)

Failure of the monsoons create further shortage of the hydel power production, leading to increased import of thermal power and hence in increased electricity costs, generating financial loss to the State Electricity Board.

All the villages of the state of Kerala have access to electricity and the percentage of households using electricity is an astounding 84 percent.

Around 40 projects are being either for generation or renovation and either running or proposed, both in public and private sectors. Government is planning some mini hydroelectric schemes. It says the State had the potential to host at least 130 small hydel projects. Some small hydroelectric units are being constructed with Chinese collaboration. Besides, 62 small projects are proposed for private investment. The 34 small projects to be completed by 2011 is expected to add an installed capacity of about 200 MW (558.819 MU). A 5MW wind farm is also proposed to be taken up during the current Plan period (experts-eye.org, 2007)

An exhaustive and comprehensive act known as the Electricity Act, 2003 has been legislated to look into the areas such as electricity generation, supply, distribution, and usage. Proper implementation of this act could do much in solving the power crisis in Kerala.

CHALLENGES AHEAD

Population is rising and so are the demands in energy sector. Changes in life style and search for better facilities, associated with the economic expansion create more demands. Negligence to the rural agricultural sector and reluctance of the new generation to the traditional jobs promote urban migration. Globalization and industrial development support this. Urban boundaries are growing and so are the demands in energy. In the urban centres, there is an increasing dependency on electricity for most of the domestic works. During the season of low power production, Government is compelled to impose power cuts. Exemption for the cities in this creates urban-rural conflicts.

Major technical and safety issue in hydel power generation in Kerala is the steep slopes of the Western Ghats Mountain. Recent studies indicate that this region is prone to minor earthquakes. As the population downstream the rivers is so huge, it can be really catastrophic. There is large scale human interference in the watersheds and rivers of Kerala that causes erosion and sedimentation. Extensive forest area in the mountains where rivers originate has been cleared for plantation crops. Vast areas of forest have been cleared illegally for tourism development. Landslides are common during every monsoon months. Erosion of topsoil and lack of route zone affect runoff during non-rainy months. Storage capacity of almost all dams in Kerala has been considerably reduced because of sedimentation. Because of uncontrolled sand quarrying from riverbeds, seven once perennial rivers became seasonal in the last century and five more are in the same way. When restrictions were made for quarrying from rivers, it became widespread in catchments. Most of the tributaries now dry up in pre-monsoon months. In spite of strict rules and regulations, both deforestation and quarrying continue uninterrupted, as result of immoral support from politicians and bureaucrats.

Anomalies and trends in climate is a major threat to hydel power generation. Monsoons that give most of the rainfall undergo wide interannual variabilities. Increasing seasonality of rainfall allows the water to wastefully flow into the sea, as capacity of dams is exceeded in the beginning of the rainy season itself. Recent studies indicate (Nair, 2006) that intensity of rainfall is increasing due to the development of convective clouds. Impact of large cloud drops cause more erosion. Also there is a decreasing trend in the rainfall from northeast monsoon. This season is the end of rainy period, and hence the decrease will affect soil moisture and runoff, and the water storage in the dams. Increasing trend in pre-monsoon temperature raises the power requirement for air conditioning and cooling.

Opposition from the ecologists is one of the major reasons in the delay in projects. Whenever the state tries to build a new hydel project, there is strong opposition from ecologists. The ecological aspects are really of concern, but many people who oppose are unable to provide a cheap alternate solution for energy crisis. With the present technical and financial set up, non-conventional energy projects cannot meet the immediate demands. As there is opposition for nuclear projects the only option is to buy from other states. This will surely raise the electric charges, but this invite strong public protest.

Another challenge in the hydel power development is the disputes over the allocation of transboundary

water. There exist disputes related to a number of major rivers, as the state lying east is in the rain shadow region and is always short in water. These disputes remain unsolved, as the political situation and attitude are not favourable. Opposition parties in States utilize the disputes in creating an image that the ruling party cannot protect the interest of the state. The ongoing gigantic project to interlinking rivers so as to minimize impacts of droughts and floods is likely to make situation complex, as more water will have to be diverted to the other state through linking.

Government machinery is often very slow, highly corrupt and there is a lack of cooperation among different government departments. It is doubtful even half of the allotted funds is really spent on projects. Several projects have been pending even for decades. Also, there are several civil cases pending in the courts, related to misappropriation of money. The state electricity board is facing a strange problem with the lack of availability of efficient technical staff in the project sites. People are reluctant to work in the remote areas and use political influence to escape from the posting in such area.

RECOMMENDATIONS

The power lines in Kerala run through thick forest and vegetation and nearly 30 per cent of the produced power is lost in transmission. Timely clearing could avoid the loss through touching and could save tremendous amount of valuable energy. Transmission lines are old and dirty that needs timely replacement. Theft of power from domestic to industrial sectors is a major issue. Permanent non-corrupt squad is needed for this.

Government agencies always have a lack of vision. They neglected the minor projects when the big Idukki project was commissioned. Government encouraged people to use electricity for cooking. In 2-3 decades, the same government had to make advertisements requesting the public not to do so. Chain of mini hydel projects downstream the river could maximum utilize the energy potential and store the maximum water for non-rainy months. Converting all existing dams multipurpose could solve much of the water and energy crisis in Kerala. The old and outdated machineries have to be replaced with new efficient machines that produce more power from existing projects. Emergency measures are to be resorted to regain the storage capacity of dams and to control further sedimentation.

To overcome financial crisis, private sector participation becomes necessary. But strict government control should be there to save the millions who cannot afford higher rates. State can also think about joint investment in project with the neighbouring state. Though rich in rainfall, Kerala depends on the water scarce Tamil Nadu for rice and vegetables. Tamil Nadu has adequate production of electricity from nuclear and thermal stations. Joint venture in agriculture and power production could solve the disputes and solve the energy and water crisis.

What the state needs is an appropriate policy for water and energy that takes into consideration the scientific, technical, environmental; economic, and social factors and an efficient and impartial political will to implement it.

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