

Study on Cauvery to Vaigai Link Canal Alignment and its Impact on Environment using IRS-P6 LISS-III Data

¹Dr. A. Shrivankumar, ¹Dr.G.Jaisankar
¹Dept. of Geo-Engineering,
College of Engineering,
Andhra University, Visakhapatnam - 530 003.

²Dr. M.Gangaraju
²Dr. Lankapalli Bullayya College (UG),
Resapuvanipalem,
Visakhapatnam 530013

³P. Anitha,³Ch. James
³Department of Geography,
College of Science and Technology,
Andhra University

Abstract: - The rainfall in the country is extremely erratic and randomly distributed. Whenever there is heavy precipitation due to monsoon/cyclones, a huge amount of water is wasted into the sea as run-off. Run-off/ surplus water can be harvested through the Cauvery – Vaigai link of river basins envisaged by National Water Development Agency (NWDA). The NWDA suggested the link canal from Cauvery River to Vaigai River to harvest the surplus water as well as the transferred surplus from Cauvery. The present study is cramped to Cauvery to Vaigai link canal, which is 256.51 km length. The study includes 10 km buffer area on either side of the alignment and the proposed command area 5407.92 km². The total study area is 9300.82 km². IRS-P6 LISS-III Satellite data of 23rd January 2010 and 15th July 2010 is utilized for the real time study. There are 46 villages fallen within the buffer area which are supposed to rehabilitate fully/partially during construction of link canal. About 2,576 villages will be benefitted by way of drinking water /groundwater recharge and additional irrigation source. The environmental impact on forest, agriculture land, roads and drainage are discussed in the study. Remote sensing study revealed that a large amount of area is under the class of scrub land (281,431ha) in the study area. Hence, this canal water is extremely useful for the mankind and at the same time mitigating floods in the donor basin (Vaigai basin).

I. INTRODUCTION:

In recent decades more than a billion people in developing nations lack access to safe drinking water, and more than 2 billion lack proper sanitation. And in the near future, water shortages are likely to spread into other key sectors — notably agriculture and energy (Nature, 2008). The resulting pressures on water supplies are unrelenting. Global energy demand is projected to increase 57% by 2030, and water demand for food production might easily double. Unless policy-makers want water resources to be constantly squabbled and fought over, with farmers pitted against city dwellers, upstream users against downstream users, and region against region, every nation needs to think about water strategically.

The rainfall in the country is mostly cramped to monsoon season and is randomly distributed with respect to both space and time. As a result, some parts of the country

are affected by frequent droughts whereas other parts are reeling under floods. Hence, the water resources development, use and conservation play a vital role in the country's development planning. The water resources in the country are, however, limited considering the future demands with tremendous increase in population influx [1]. The erstwhile union minister of irrigation, Central Water Commission (CWC) proposed national perspective plan (NPP) proposal for water resource development and later the Center established NWDA in 1982 to give concrete shape to NPP by conducting scientific studies on interlinking of rivers. This major component of peninsular of river linking, more known as southern grid, consists of 9 linking projects for transfer of combined surplus 26,000 Mm³. The present study Cauvery to Vaigai is one of the link from the River Cauvery to Vaigai. However, diversion is for 2252 Mm³ as per the proposal from Cauvery to Vaigai. Inter basin transfer of water is not a new concept [2]. To name a few India have many such operations, like Kurnool- Cuddapah canal, Sardar Sarovar canal etc. The need for any of the extents of transfer depend on the irrigating potential intended to be achieved in the three basins of Krishna, Pennar and Cauvery, which are traditionally recognized as water short basins. Based on the annual rain fall, a surplus of 14,775m² is run-off into the Bay of Bengal [3]. As per the [4], 79% of its geographical area is in drought prone in Krishna and Pennar basins.

In the conceptual framework of reductionist engineering, it will be a win- win situation if one can simply utilize “the water otherwise going to waste in the surplus river basins” [5]. The process for the assessment of irrigation, domestic and industrial needs are given in some details in the Report of the Working Group on Inter basin Transfer of Water [6]. The National Water Development Authority [7] after a thorough study indicated that Himalayan rivers, especially, Brahmaputra and Ganga have exceedingly surplus quantum of water, and hence, proposed transfer of water from these surplus basins to deficit basins in peninsular region [8][9]. Many researchers discussed on harvesting excess water in basin and its pros and cons at

length [8], [10],[11],[12], [13] and [14]. The study so far conducted on the proposed links connecting Mahanadi with Andhra Pradesh and Tamilnadu shows the possibility of bringing nearly 7000 Sq km area of an un-irrigated, wasteland come under irrigation in Andhra Pradesh alone. Many earlier reviewers [8], [11]; [9]; [15]; [16]; [17] have discussed the pros and cons of linking of river basins in India. Even though the problem seems to raise many controversies, the country is now going ahead at intra-state level with projects like Buckingham canal in Taminadu and Eleru in Andhra Pradesh and inter-state project like Almatti and Telugu Ganga which are in successful operation adopting methods to reduce losses in social sector.

Cauvery - Vaigai link canal takes off from the existing Cauvery (kattalai) barrage from its right flank of the existing Kattalai bed regulator with FSL at 100.75 m and designed capacity of 180.30 cumecs and runs parallel to the Cauvery Right Bank Canal to its right side. The Cauvery – Vaigai link canal is proposed as a contour canal running for a total length of 255.60 km till it joins with vaigai reservoir. The canal generally runs in south direction. The canal passes through the talukas of Macherla, Durgi, Karampudi, Piduguralla, Nekarikallu, Ipuru and Bollapalli of Guntur district, Pullala Cheruvu, Tripurantakam, Donakonda, Kurichedu, Konakanamitla, Podili, Kanigiri, Veligandla and Pamuru of Prakasam district and Varikuntapadu, Udayagiri, Duttalur, Marrisapadu and Anantasagaram mandals of Nellore district.

II. GEOGRAPHICAL LOCATION OF THE STUDY AREA:

The link canal lies in TamilNadu state having a length of 255 km. This connects tributary of Cauvery and Vaigai rivers at Krishnapuram. The link alignment map is taken from NWDA literature in PDF format and geo-referenced to

overlay on Survey of India (SOI) topographic maps and google earth maps, to study various land features and the environment. The alignment is overlaid on SOI topo-grid to identify required maps for the study area. Taluka and district boundaries are taken and overlaid on the alignment to identify the study area covered in various districts and talukas. Alignment is shown in Fig. 1.1. along with the study area. The figure shows the coverage of the study area on either side of the canal along alignment direction. The alignment starts from Mayanur village in Kulittalai taluka in Salem district spreading to an area of about 8.21 km² and passes through Tiruchchirappalli taluka of Tiruchchirapalli district covering a length of 66.34 km and spread to an area of 1479.10 km². In Pudukkottai district, the canal passes through Kulattur, Pudukkottai, Tirumayam talukas travelling 75.6 km and covering an area of about 2004.19 km². In Pasu Muthuramalingam district, the canal passes through Tiruppattur, Karikuddi, Sivaganga, Manamadurai talukas spread to an length of 91.84 km. In Kamarajar district, the canal passes through Tiruchuli, Aruppukattai taluka covering a length of about 22.73 km. The study area is bounded by latitude 9°8'49"N to 11°3'2"N; longitude 79°9'48"E to 78°3'36"E latitudes.

we extensively use geographic information system (GIS) in this study. From the topo-sheet mosaic prepared earlier, all settlements are extracted in GIS environment and district boundary, mandal boundary and villages of each mandal are integrated as shown in Figure 1. One kilometer buffer is created in Arc GIS on either side of canal alignment and it was found that 46 villages fall within the buffer area and these are to be rehabilitated during the construction of link canal.

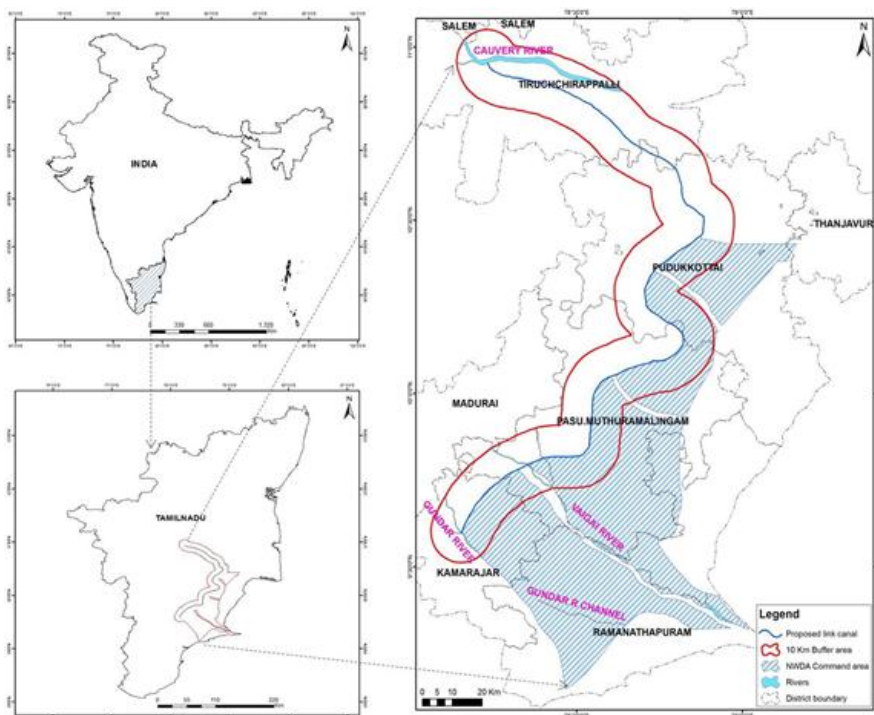


Figure 1. Location of the study area with district and mandals.

III. METHODOLOGY AND MATERIALS USED:

The basic water resources data for Cauvery-Vagai link alignment and other salient feature are collected from NWDA, website <http://www.nih.ernrt.in> in National Atlas Thematic Mapping Organisation (NATMO) maps published in the year 1968 map series were collected for generation of slope, geology, and geomorphology. Soils maps were collected from the published Atlas of NATMO. The methodology comprises the use of geospatial data namely SOI topographic maps on 1:50,000 scale of 1969 and Indian Remote Sensing Satellite IRS P6 (LISS-III sensor data) digital data. The relevant literature in the form of published maps, reports, books and articles are consulted, the major thematic maps namely geology, geomorphology and soils are generated using NATMO maps in JPG format using onscreen digitization. Drainage, surface water bodies, infrastructure and forest cover are generated using onscreen digitization from SOI topographic maps. Land use/land cover, rock exposure and forest cover changes and lineaments are divided from IRS P6 LISS-III satellite data. The SOI topographic maps are rectified using Erdas Imagine 2014. Then the images covering the study area are rectified with equally distributed GCPs based on the topo-sheet. Drainage and villages are vectorised using ArcGIS 10.5 with integrated tools of the GIS software produce for building complete GIS applications. The SOI topographic maps are collected from the Department of Geo-Engineering, College of Engineering (A), Andhra University followed by 58I/4, 58I/8, 58J/1, 58J/5, 58J/9, 58J/10, 58J/14, 58J/11, 58J/15, 58J/116, 58N/3 58K/1, 58K/2, 58K/5, 58K/6, 58K/7, 58K/8, 58K/9, 58K/10, 58K/11, 58K/12, 58K/13, 58K/14, 58K/15, 58O/3 respectively.

IV. GEOLOGICAL SETTING:

The linkage canal is also depends up on the geological setting an any area of landmass, hence we discuss about the present geological setting of the Cauvery-Vagai link, in this Cauvery – Vagai alignment we findout three types of geological structure classes they are namely Ar Undivided (Dharwar sys., Aravalli Sys., Sausar Sr., Sakoli Sr., Chilpighat Sr., Bijawar Sr., Gangpur Sr., Iron Ore Sr., Archaeans of Eastern Ghats & Shillong Sr.), ep PC, Undivided, including areas with Mesozoic-Cainozoic covers on the marginal parts of the peninsular platform (also sineclises and troughs),

V. SURFACE MORPHOLOGY:

The study area polygon is taken and canal alignment is overlaid on the digitized geomorphology map to demarcate various land forms pertaining to the study area (Figure 1). The alignment length from 0 to 64.2 km is in Thiruchurapalli district. The study area in this district is occupied by pediplain and pediplain shallow. The canal which is 75.6 km in length is covered in Pudukkottai district where it passes through 2 types of landforms;

floodplain coastal plain, In Pasu Muthuramalingam district, the canal covers 91.84 km and about 2988.42 sq km area stretched. In the district of Ramanathapuram have two type of landforms found such as coastal plain and young coastal plan whereas it stretches the area is around 1931.64 sq km. The weathered pediplain is the dominant landform covering major areas (9300.82 sq km) in all the 8 districts of the study area and occurs at a distance of 255 km. In this proposed canal most of the land forms which we are discussed above hence in Madurai, Saleem and Samanthapuram districts absent the landforms they are Flood plain Coastal plain Pediplain shallow.

VI. SOILS:

In order to study soils along the alignment and the Command area, a soil map is geo-referenced with the help of topo-sheets in Arc GIS 10.5. After geo-referencing, all soil layers are digitized manually andcoverages were created. The alignment and the study area boundaries are super-imposed on the digitized soil map to demarcate various soils along the alignment and their spread in the study area. The alignment traverses about 101.81 km in Sandy clay loam, 92.49 km Sandy loamy soil and 58.0 km in finy sandy loamy soils and loamy soils stretches around 3.87 km in study area. The Command area along the alignment is mostly occupied with sandy clay loamy soils, clayey soils and gravelly clay. In Pasu Muthuramalingam district, about 61.98 km of canal is in sandy clay loam soils, 51.63 km in fine sandy loam soils and 14.71 km in sandy loamy soils. About 91.84 km length of the canal is covered, moreover 75.6 km is through Sandy loam and Sandy clay loam in Pudukkottai district, 51.63 km in fine sandy loam soil and 14.71km sandy loam in Tiruchchirapalli district. The Cauvery-Vagai link alignment stretches 256.51 km and occupies an area of 9300.82 sq km. (Fig.2 c).

VII. SATELLITE DATA ANALYSIS:

The relevant SOI topographical maps on 1:50,000 scale and the base maps surveyed in 2014 were used in geo-referencing the IRS-1D satellite data (Table 1) The IRS-1D digital data was geo-referenced to geographic latitude and longitudes, using ground control points derived from the SOI topo-sheets and the mosaics were created in ERDAS Imagine 2014. The study area buffer, the alignment and the command area are overlaid on the LISS-III mosaic data of two scenes which covers the study area (Fig.2 d). The satellite image of the area and forest boundary AOI, extracted from topographic maps, is overlaid and the status of the forest is examined. The image shows that there is hardly any forest seen from the image, though there was forest marked in SOI maps. Most of this area is noted as deforested. Through, the canal alignment passes through the reserved forest area, yet there would be hardly any forest loss, but 30 sq km of this area would be disturbed while the canal construction (Fig 2 d).

Table 1. Satellite, sensor and image particulars.

Satellite	Sensor	Path	Row	Date	Resolution
IRSP6	LISS-III	101	066	23-JAN-2010	23.5m
IRSP6	LISS-III	101	067	23-JAN-2010	23.5m
IRSP6	LISS-III	102	066	15-JUL-2010	23.5m

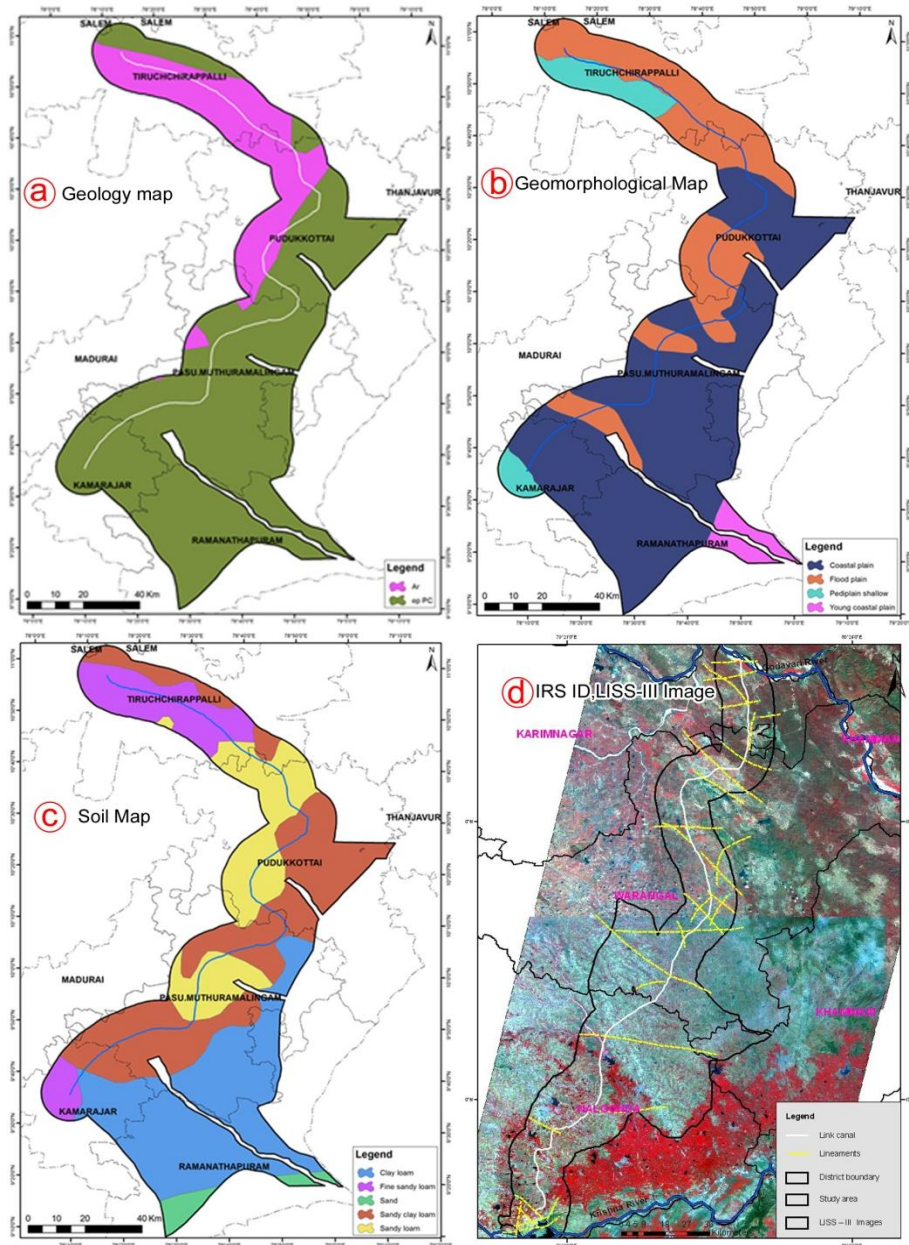


Fig. 2 (a-d). Geology, Geomorphological, soil and IRS LISS III image maps of the study area.

VIII. SURFACE LINEAMENTS EXTRACTION:

The satellite images due to its many capabilities such as the synoptic aerial coverage, multi spectral captivity of data, temporal resolution, etc., produce better information than conventional aerial photographs (Lillesand and Kiefer, 1999), so the same was selected for the task of extracting surface lineaments. With the help of image interpretation keys and elements, lineaments are interpreted for the entire study area. As the digital image enhancement techniques can contribute significantly in extracting lineaments, the same

has been attempted using the software ERDAS 2014. Geological lineaments / faults zones are identified and drawn through screen digitization of image mosaic (Fig.d). 3 lineaments were demarcated in the study area in Tiruchurapalli district and 4 in the Pudukkottai district. In Pasu Muthuramalingapuram district has 1 lineaments in study area, (Table.3)

Table.3 Surface lineaments of The Kauveri Vagai link canal

District	Lineaments No.	Alignment length (km)
Tiruchchirappalli	1	0.51
	3	36.91
	4	43.87
Pudukottai	5	73.37
	6	85.25
	7	92.73
Pasu. Muthuramalingam	11	144.89

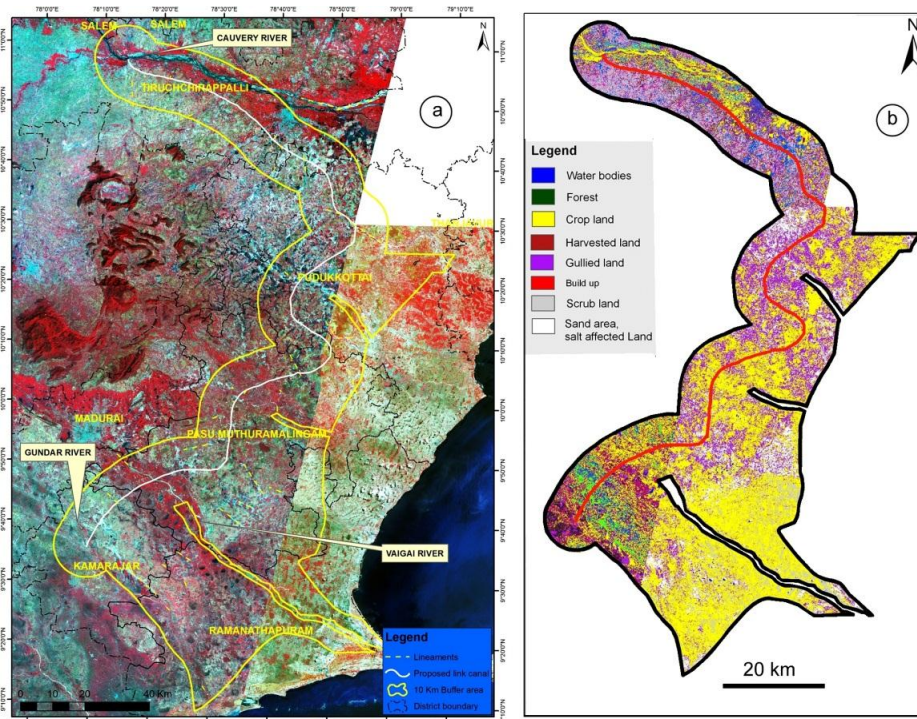


Fig.3 IRS- P6, LISS-III image mosaic with lineaments and Land use/Land cover classes: Cauvery-Vagai link canal

Table.2 Land use / Land cover

Categories of LULC	Area (sq.km)	Percentage (%)
Water bodies	24032.14	2.62
Cropland	312081.81	34.04
Gullied land	166734.04	18.19
Scrub land	281431.78	30.70
Fallow land	19386.31	2.11
Sand	58617.84	6.39
Forest	44887.72	4.90
Others	9629.00	1.05
		100.00

IX. LAND USE / LAND COVER IMPACT ON ENVIRONMENT:

The proposed link canal between The cauvery – vagai situated among 8 districts in Tamilnadu State India. The total command area is 5407.92 sq km, buffer area is around 3892.91 sq km and the total area of The cauvery – Vagai link is 9300.82 sq km in these 8 districts. The proposed catchment area consists of 4.90 % of forest, 34.04% of crop lands, 2.62% of open water bodies, 30.70%

of scrubs, fallow land and 2.11% , 6.39% of sands in study area moreover 18.19% of gullied land and 1.05% is other land varieties in study area. (NWDA-2003). To estimates forest loss due to the alignment of the canal in the study area, an attempt was made by considering a width of 0.5 km on either side of the canal.

There are 46 villages fallen within the buffer area which are supposed to rehabilitate fully/partially during construction of link canal. There are 4 villages in Tiruchchirappalli district, 17 villages in Pudukkottai district,

22 villages in Pasu Muthutamalingam district and 3 villages in Kamarajar district which are fallen within this zone. The canal would meet drinking water needs of thaluks's and plantations in this study area. The canal would supply water for the land on either side of the canal where lands were rain-fed and drinking water needs of 2576 villages. The proposed Command area 9300.82 sq km was classified as wasteland class which could come under irrigation by the canal water.

Out of the total study area 9300.82 sq km, only 20% is under crop rain-fed land and about 18.19% is classified as gullied land and scrub land which accounts for 281431.78 sq km. The canal supplies water to this area and is brought under irrigation if the canal could be implemented. About 256.51 km length of canal is through Ar, Ep, Pc class where precautions could be taken to line the canal to arrest possible seepage losses. Sand clay loamy soil and clay loam soil occupied 194.64 sq km in study area of The Cauvery – Vagai canal. The clay loamy soil occupied the minimum area of 3.87 km in kamarajar. canal surroundings and all 2576 villages would benefit from protected water supply permanently besides land irrigation in the study area.

X. CONCLUSION:

The study describes the Cauvery-Vagai link canal, which is one of the proposed by NWDA. The study confined to 10 km buffer area on either side of the alignment and the command area 5407.92 sq km proposed. The total study area is 9300.82 sq km. The study revealed that 2576 villages, which are fallen in the alignment, and 46 villages affected by this canal. IRS-P6 AWiFS Data revealed that a large extent of area is under the class of crop and scrub land (Table 2) besides the canal proposed command area of 5407.92 sq km. The demarcation of the drainage revealed ninth (0 – 150 length), 4 th order basins in the total stretch of the alignment. These can be considered while constructing the canal. Six major rivers also cut across by the canal alignment. Beyond Durgi mandal canal passes through forest area of Karempudi, Guntur, Piduguralla and Nakarikallu mandals. Forest loss will be about 125 sq km area in this stretch of the alignment due to construction of the canal. About 65.96% area of agricultural land will be affected in the plains due to alignment of the canal and water longing. 33 mettal roadways and about 49 unmettled roads will be affected due to the canal alignment in 8

districts. The integration of themes from SOI sheets and remote sensing data in GIS has revealed the above results.

With the implementation of the scheme, living standards of the local farmers, in general, would improve because of better yields from their fields and hence higher returns for their work. The expected multiple benefits with time will over-weigh the feared losses at the time of implementation of the project.

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