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# Study on Nagarjunasagar to Somasila link canal alignment and its impact on environment using IRS-P6, AWiFS data

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**ABSTRACT**

The rainfall in the country is extremely erratic and unevenly distributed. A huge amount of water is wasted into the sea as run-off whenever there is heavy precipitation due to monsoon/cyclones. Run- off/ surplus water can be harvested through the proposed linking of river basins envisaged by National Water Development Agency (NWDA). The NWDA suggested three link canals from Krishna River to Pennar River to harvest the surplus water as well as the transferred surplus from Godavari. The present study is confined to Nagarjunasagar to Somasila link canal, which is one of them, is 341 km length. The study includes 10 km buffer area on either side of the alignment and the proposed command area 3252 sq km in Prakasam district. The total study area is 9,367.5 sq km. IRS-P6 AWiFS data of March 2009 is utilized for the real time study. The study revealed that 162 villages, which are fallen in the alignment, are to be rehabilitated while executing the canal. About 1202 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 extent of area is under the class of wasteland (229,483 ha) 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 (Krishna basin).

## INTRODUCTION

The rainfall in the country is mostly confined to monsoon season and is unevenly 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 (Bandyopadhyay & Mallik 2003). The Erstwhile union minister of irrigation, Central Water Commission (CWC) proposed national perspective plan (NPP) proposal for water resource development and latter 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 $Mm^3$. The present study Nagarjunasagar to Somasila is one of the three links from the River Krishna to Pennar. However, diversion is for 16,500 $Mm^3$ as per the proposal from Godavari to Krishna.

Inter basin transfer of water is not a new concept (Rao 1975). To name a few India have many such operations, like Kurnool- Cuddapah canal, Sardar Sarovar canal etc. The need for any 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 14,775$m^2$ is run- off into the Bay of Bengal (Selvam 2003). As per the CWC (1998), 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" (NCIWRDP 1999a). 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 (NCIWRDP 1999b). Many researchers discussed on harvesting excess water in basin and its pros and corns at length (Reddy 2003, Biyani & Gupta

2004, Radhakrishna 2004, Sharma 2006, Jain, Vijay Kumar & Panigraphy 2008 and Prakasa Rao et al., 2010).

Nagarjunasagar - Somasila link canal takes off from the existing Nagarjunasagar reservoir from its right flank earth dam and runs parallel to the Nagajunsagar Right Bank Canal ( NSRBC) to its right side, till both the canals amalgamate into one at reduced distance (RD) 202.75 km. Beyond this point up to its out-fall into Somasila reservoir, the canal generally runs in south direction. The canal passes through the mandals 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, Marripadu and Anantasagaram mandals of Nellore district.

The Krishna is the second largest river in the peninsular India flowing east and draining into the Bay of Bengal. The river rises in the Mahadev range of the Western Ghats near Mahabaleshwar at an altitude of about 1337 m above mean sea level and flows through the states of Maharashtra, Karnataka and Andhra Pradesh. The total length of the river from source to its outfall into Bay of Bengal is about 1400 km. The Pennar river is also a river of the Indian peninsula flowing eastwards and draining into the Bay of Bengal. The river rises in Chennakesava hills of the Nandidurg range in Kolar district of Karnataka state. The total length of the river from the source to its out fall into the sea is 597 km, of which about 61 km is in Karnataka and the remaining 536 km is in Andhra Pradesh.

There are three link canals from the river Krishna to Pennar River. Nagarjunasagar reservoir to Somasila dam link canal is one of them under study. The study area covers an area of 9,367.48 Sq.km including the 20km width along length of the link and command area. The area covered in 30 Survey of India topo-sheets. Study area comprises 10km buffer zone on either side of the alignment.

The study area Nagarjunasagar – Somasila link canal lies between $79^0.31'$ to $79^0.27'$ East longitudes and $16^0.57'$ to $14^0.49'$ North latitudes. And this canal covers parts of Guntur, Nellore, and Prakasam districts of Andhra Pradesh State only. The length of total canal is 341 km. (Fig.1) People living in the enroute command area are mostly dependent on agriculture and extending irrigation facilities to an extent of 1.68 lakh ha will not only increase agricultural production but also create all-round prosperity. The scheme is intended (i) to provide irrigation facilities to enroute areas lying in the districts of Prakasam and Nellore where the existing irrigation facilities are not adequate and occurrence of frequent droughts is common, and (ii) to divert remaining surplus water further south beyond.

## METHODOLOGY

The proposed river link maps of peninsular component downloaded from NWDA department site http://nwda.gov.in/nwda/proposals/feasibility in jpg format. These link canal alignment maps are geo-rectified prior to demarcation of study area for each link. In GIS, buffer zone is generated at a width of 10 Km on either side of the canal alignment to extract effective study area enroot including the command area under this link for study (Fig.2). Prior to digitization, the SOI maps have been geo- referenced by giving ground control points. The 1:50,000 scale SOI data base is used to assign, polyconic projection system. Later the map has been registered to real world co-ordinates using ERDAS IMAGINE 9.1 software. Total 30 topo-sheets are rectified and prepared a subset as per the study area polygon.

| | |
|---|---|
| Nagarajunasagar-Somasila link canal and command area | 56P/ 2,3,6,7,8,11,12,15,16<br>57M/ 5,6,7,8,9,10,11,12,13,14,15,16<br>57N/ 2,3,5,6,7,9,10<br>66A/ 3,4 |

A topo-sheet mosaic is prepared for all the SOI maps which fall in the study area. From this mosaic image, study area is extracted using shape file in the software. A point data map is prepared from the mosaic and village names are given as attribute file. There are 1202 villages in the study area spread in Guntur, Prakasam and Nellore districts. Earlier geo-referenced alignment is superimposed on the study area and found some villages are fallen in the alignment. To identify the villages under threat one kilometer buffer is created on either side of the alignment. These are 162 villages fallen in this hot zone which are to be rehabilitated. All the villages that are identified from the study area are shown in the Table 1.

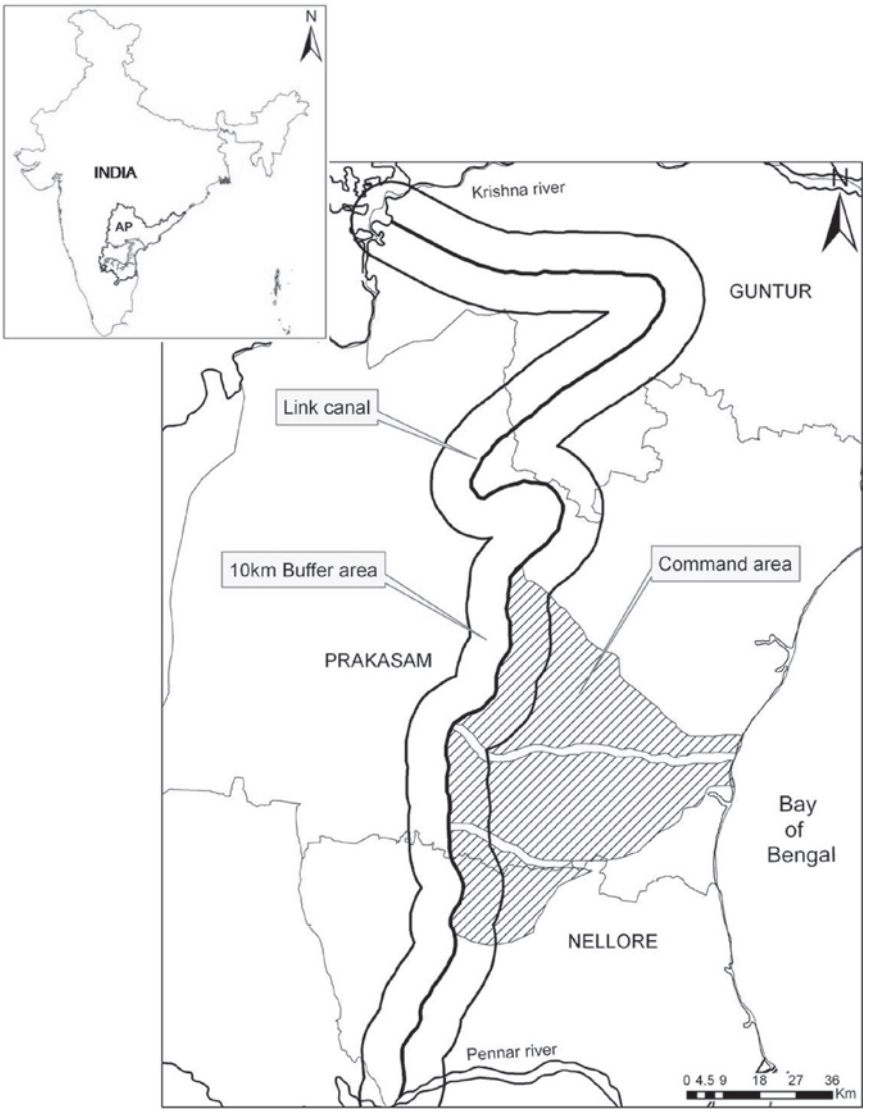


**Figure 1.** Nagarjunasagar to Somasila link canal study area.

**Table 1.** Villages covered in the study area with mandals.

| S.No | Districts | Mandals and (villages) |
|---|---|---|
| 1 | GUNTUR | Bollapalle(32),Durgi(17),Ipuru(21),Karempudi(12),Macherla(23), Nakarikallu(15),Nuzendla(27),Piduguralla(5),Rajupalem(1),Rompicherla(19),Savalyapuram(8),Veldurthi(8),Vinukonda(16). |
| 2 | PRAKASAM | Chadrasekarapuram(2),Darsi(38),Donakonda(26),Gudluru(7),Hanumanthunipadu(10),Kandukur(50),Kanigiri(88),Konakanamitla(29),Kondapi(27),Kothapatnam(1),Kurichedu(27),Lingasamudram(24),Marripudi(60),Mundlamuru(4),Pamu(R73),Pedacherlopalle(69),Podili(43),Ponnaluru(51),Pullalacheruvu(2),Singarayakonda(25),Tangutur(9),Tripurantakam(29),Ulavapadu(2),Veligandla(30),Voletivaripalem(43),Zarugumilli(24). |
| 3 | NELLORE | Ananthasagaram(29),Duttalur(35),Kaluvoya(14),Kondapuram(21), Marripadu(40),Udayagiri(7),Varikuntapadu(28),Vinjamur(15) |

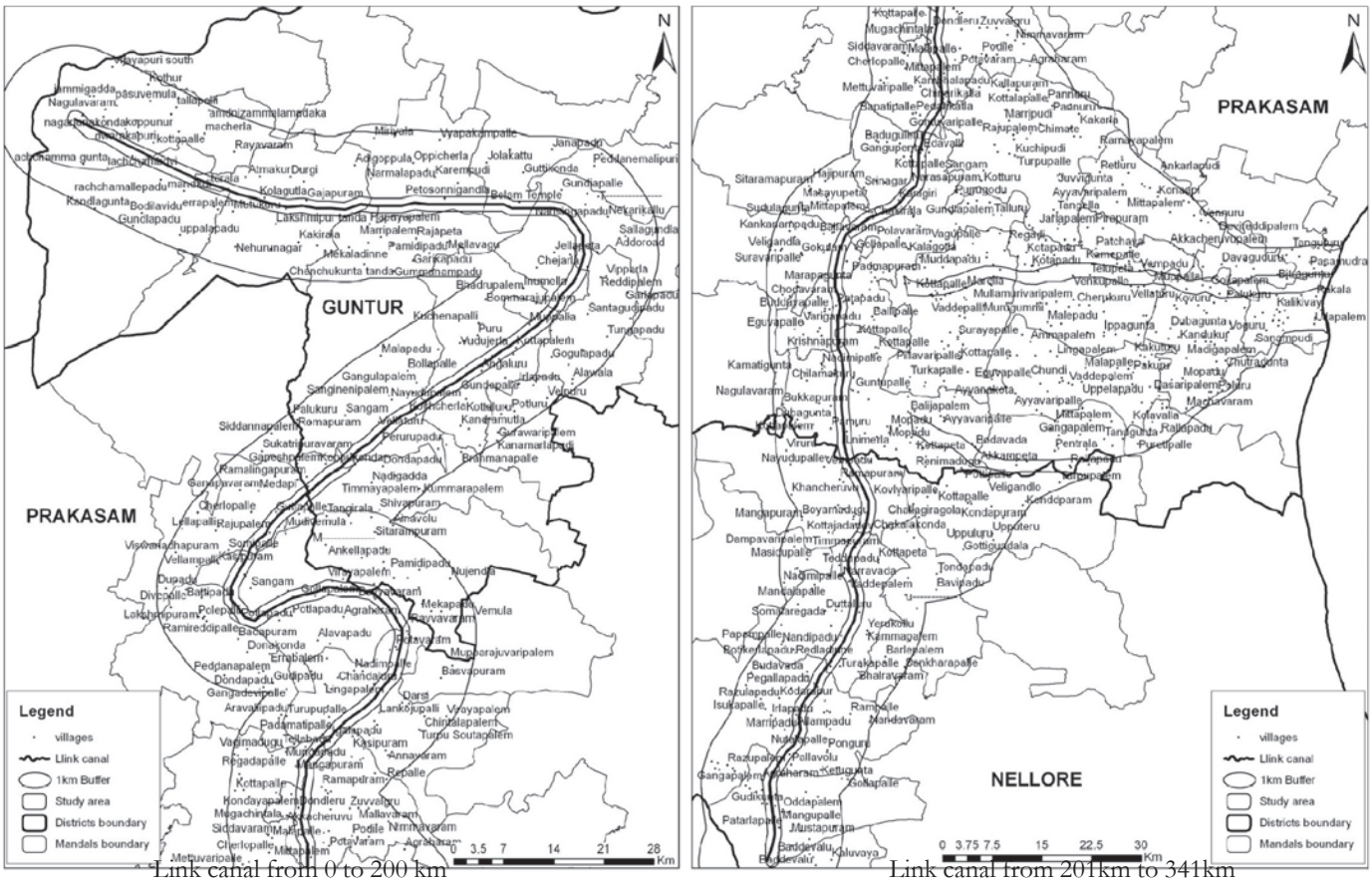


**Figure 2.** Villages, mandals and districts of the study area.

## Topography

The proposed 341 km long link canal taking off from the Nagarjunasagar reservoir near Nagarjunakonda runs parallel and adjacent to the existing NSRBC on its right side to a distance of 202.75 km. It is proposed as the contour canal and finally falls in to Somasila reservoir in the river Pennar. The canal is aligned along the Eastern Ghats, skirting the Vinukonda, Markapur and Velikonda hilly ranges. The canal mostly runs in plain area except at the crossings of basin ridges between various rivers, enroute. About 39 km length of canal goes through stony waste and hilly area in Ipuru, Donakonda, Kurichedu, Darsi Kanigiri and Karempudi mandals. The most part of canal cut across plain areas of Bollapalli ,Vinukonda, Tripuranthakam, and Kurichedu in Guntur district. In Prakasam district, Kurichedu, Nuzendla, Darsi, Konakanamitla Piduguralla, Nakarikallu mandal plains are traversed by the canal parallel to Nagarjunsagar right canal.

Beyond this mandal it entirely goes through plains of Nelluru district and it joins Somasila reservoir. A tunnel of length 1.265 km has been proposed across Pasuvemula ridge between RD 3.580 km and 4.845 km, parallel to the existing Pasuvemula tunnel of NSRBC.

Major soil types encountered along the alignment are black cotton and red sandy soils. Geologically, the northern part of the region along the canal alignment is characterised by Cuddapah and Kurnool formations upto Kurichedu. Thereafter and upto the Somasila reservoir, the link canal passes through Dharwars, which comprises of slates, phyllites, schists, gneisses, marbles, gneissic complex and associated basic and ultra basic intrusives.

## Drainage

Again topo-sheets mosaic of study area is considered as base to extract drainage. The shape files are created for drainage, tanks and rivers, and extracted them from the study area. After the delineation of drainage, orders are given to each stream (Horton 1932**).** Based on the orders of streams, basin boundaries are demarcated accordingly where the highest order stream ends

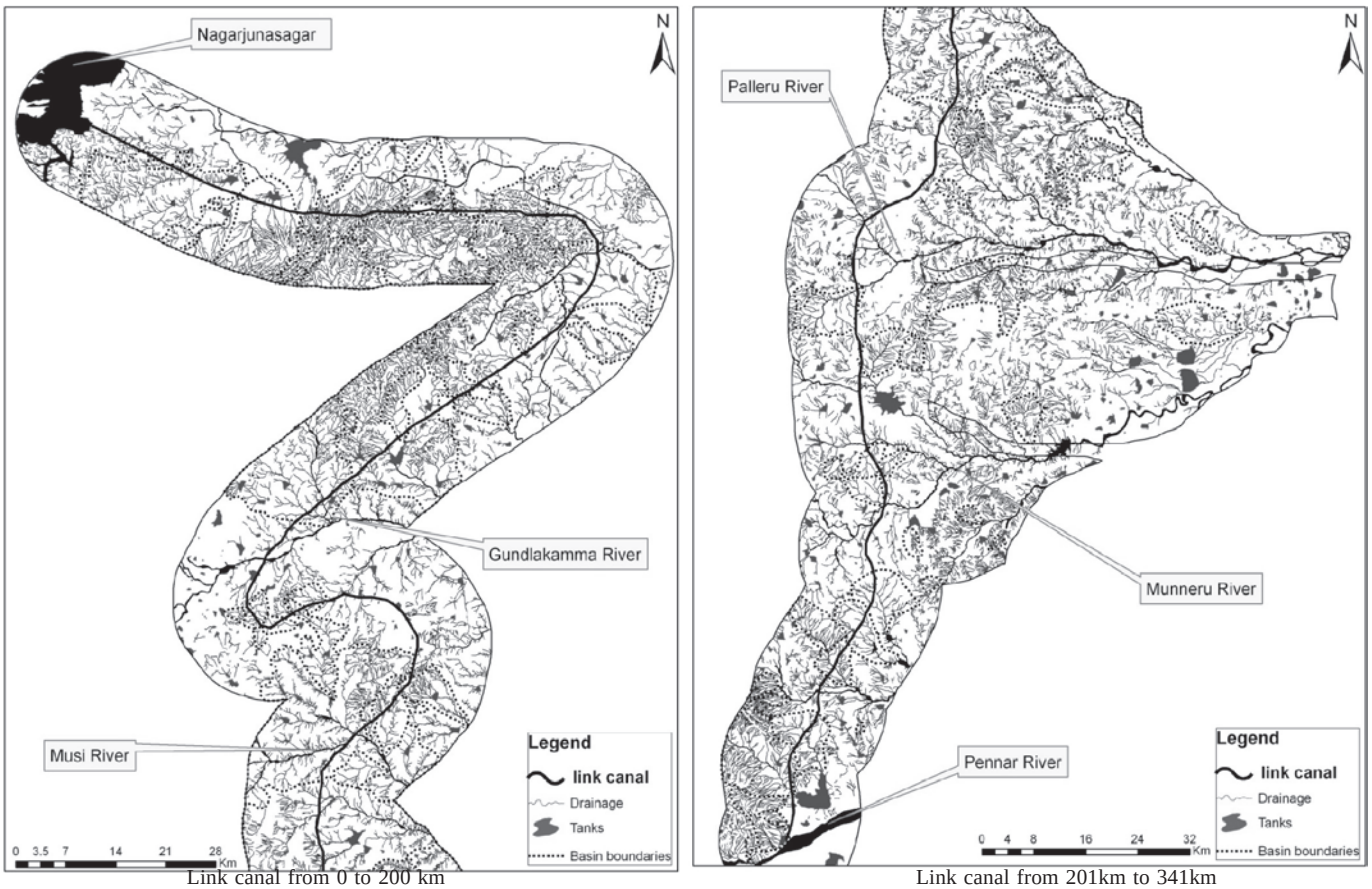


**Figure 3.** Drainage and basin boundaries of the study area.

(Morisawa 1958). The drainage and surface water bodies map is prepared using SOI topo-sheets on 1:50,000 scale. Along this link canal alignment eighteen basin boundaries are demarcated (Fig.3). These basins are listed below in Table 2 (Pidwirny 2006). The total link canal study area consists of 30165 first order streams, 4688 second order streams, 1409 third order streams, 399 fourth order streams and 18 fifth order streams (Strahler 1964). The total basins and their characteristics are shown in Table 2. The proposed enroute command area is well drained by rivers/streams like Musi, Palleru, Manneru and also by a number of major/minor drains. As such, the proposed command area is not likely to encounter any serious drainage problem. However, certain provision is made in the estimate for providing drainage facilities in the command area. The information available on natural drainage system in the command area in the form of streams, nallas etc. is discussed bellow. Since the branch canals and major distributaries are planned as ridge canals, no major drainage problem is anticipated in the command area (NWDA 2003).

## REMOTE SENSING STUDIES

AWiFS sensor data of IRS-P6 Satellite is acquired from NRSC (NATIONAL REMOTE SENSING CENTER). AWiFS images are taken and imported to image format and then geo-referenced with respect to the mosaic Survey of India topo-sheets data base and then projected to polyconic projection. IRS –P6 AWiFS image of 56m spatial resolution, 99 / 60 path and row scene dated 7th March 2009 is studied.

### Land use/land cover

Study area shape file, prepared earlier, is taken and overlay on the geo-referenced image to extract / subset the study area from the image (Fig .4). The subset image is adopted in ERDAS to classify the image using supervised classification adopting the Minimum distance to means classification. The NRSA (2006) classification scheme was adopted from Manual of land use / land cover mapping for delineation of the Land use / land cover classes digitally from the subset image.

**Table 2.** Drainage characteristics of the study area.

| S.No | Name of the basin | Steam orders Length(m) | Area of the basin(sq.km) | Drainage Density |
|---|---|---|---|---|
| 1 | Tati vagu | 17445 | 7.16 | 2.43 |
| 2 | Vedulapaya vagu | 47311 | 11.9 | 3.97 |
| 3 | Gundalavagu | 102681 | 24.71 | 4.15 |
| 4 | Angaturu vagu | 57165 | 26.14 | 2.1 |
| 5 | Kalli vagu | 59026 | 19.91 | 2.96 |
| 6 | Nerella vagu | 48327 | 25.76 | 1.87 |
| 7 | Gogana vagu | 68475 | 53.68 | 1.27 |
| 8 | Marella vagu | 231407 | 99.35 | 2.32 |
| 9 | Kappala vagu | 77515 | 44.22 | 1.75 |
| 10 | Edibogula vagu | 70107 | 47.07 | 1.48 |
| 11 | Erra vagu | 290332 | 84.08 | 3.45 |
| 12 | Kanuma vagu | 86520 | 26.32 | 3.28 |
| 13 | Kudumula vagu | 98882 | 43.33 | 2.29 |
| 14 | Pallavoluvagu | 102187 | 53.56 | 1.9 |
| 15 | Gubala vagu | 63158 | 46.37 | 1.36 |
| 16 | Savuta vagu | 22097 | 18.96 | 1.16 |
| 17 | Dornapuvagu | 82577 | 34.27 | 2.4 |
| 18 | Chandravanka vagu | 247028 | 111.81 | 2.2 |

Ground truth was collected during March for all land use classes identified from the satellite data. Final land use map is prepared by incorporating the field observations.

All together eight land use /land cover classes are identified as per level-II classification legend. The land use/land cover map is shown in Fig.5. The study area is classified into water bodies, agricultural land, forest, scrub land, plantations, gullied land, fallow land and others.

**Agricultural land**

These are the lands primarily used for farming and for production of food, fiber, and other commercial and horticultural crops. It includes land under crops (irrigated, un-irrigated, current fallow etc.). Croplands are the areas with standing crop as on the date of satellite overpass. Cropped areas appear in bright red to red in color with varying shape and size in a contiguous to non-contiguous pattern. The crop land, fallow land and horticultural crops come under this category. In the study area the agricultural land is estimated as148,209.5 ha.

**Forest**

These are the areas bearing an association predominantly of trees and other vegetation types (within the notified forest boundaries) capable of producing timber and other forest produce. They appear dark red to red in tone of varying sizes. The size can be irregular and discontinuous occupying medium relief mountain / hill slopes within the notified areas. The total aerial extent of this category is 219,307.37 ha.

**Scrub land**

This is a land, which is generally prone to deterioration due to erosion. Such lands generally occupy topographically high locations, excluding hilly / mountainous terrain. They appear in light yellow to brown / greenish blue depending on the surface moisture cover and vary in size from small to large having either contiguous or dispersed pattern. Scrublands are associated with moderate slopes in plains and foot hills and are generally surrounded by agricultural lands. The total aerial extent of this category is 83,204.66 ha in the study area.

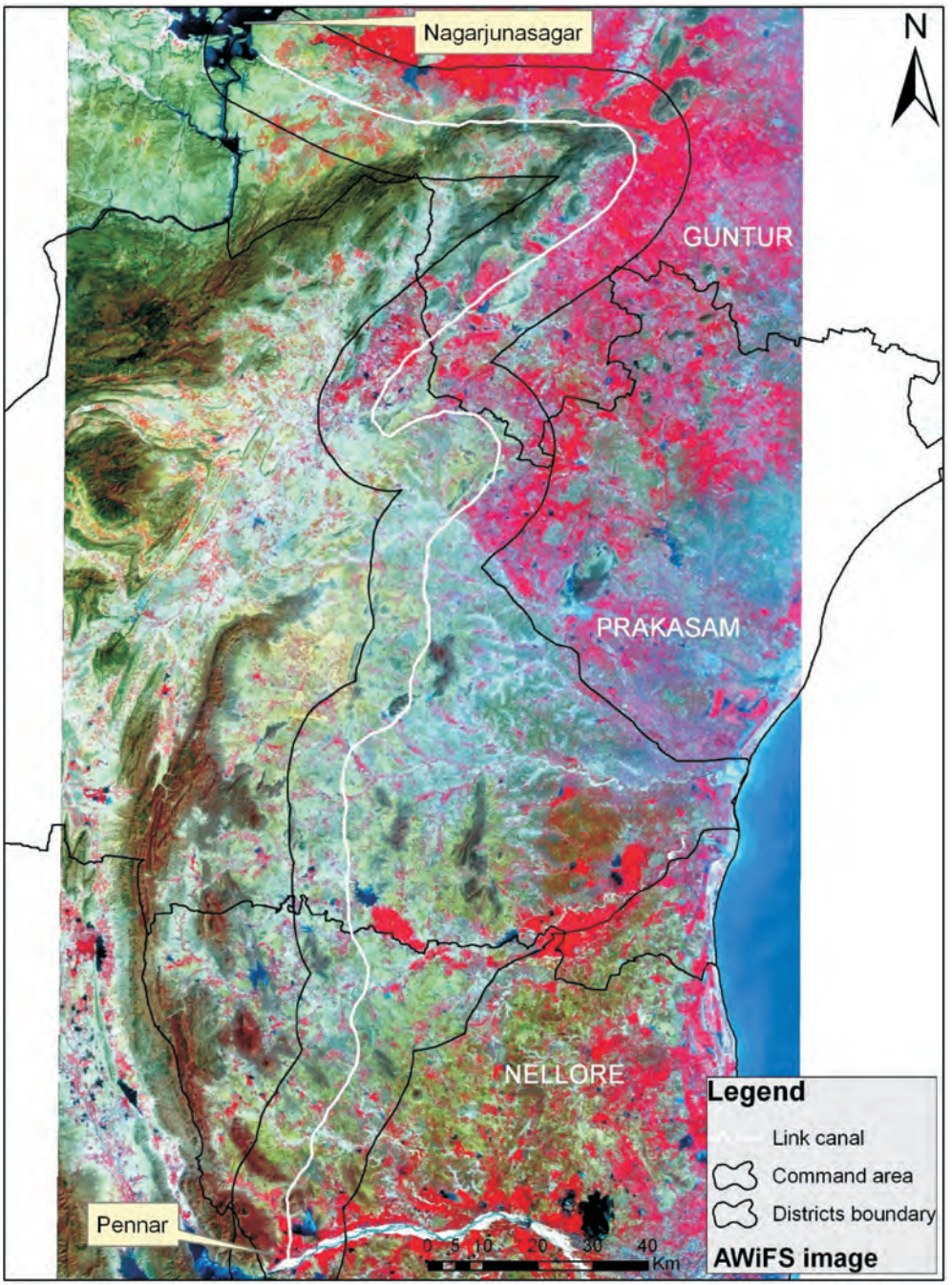


**Figure 4.** AWiFS Image of the study area.

### Water bodies

This category comprises areas with surface water, either impounded in the form of ponds, lakes and reservoirs or flowing as streams, rivers, canals etc. These are seen clearly on the satellite image in blue to dark blue color depending on the depth of water. This class is occupied 75,069.09 ha land in the study area.

### Plantations

Plantations appear in dark-red to red tone of different sizes with regular and sharp edges indicating the presence of a fence around it. Depending on the location, they exhibit a dispersed or contiguous pattern. The total aerial extent of the agricultural plantation is 87,828.56 ha in the study area.

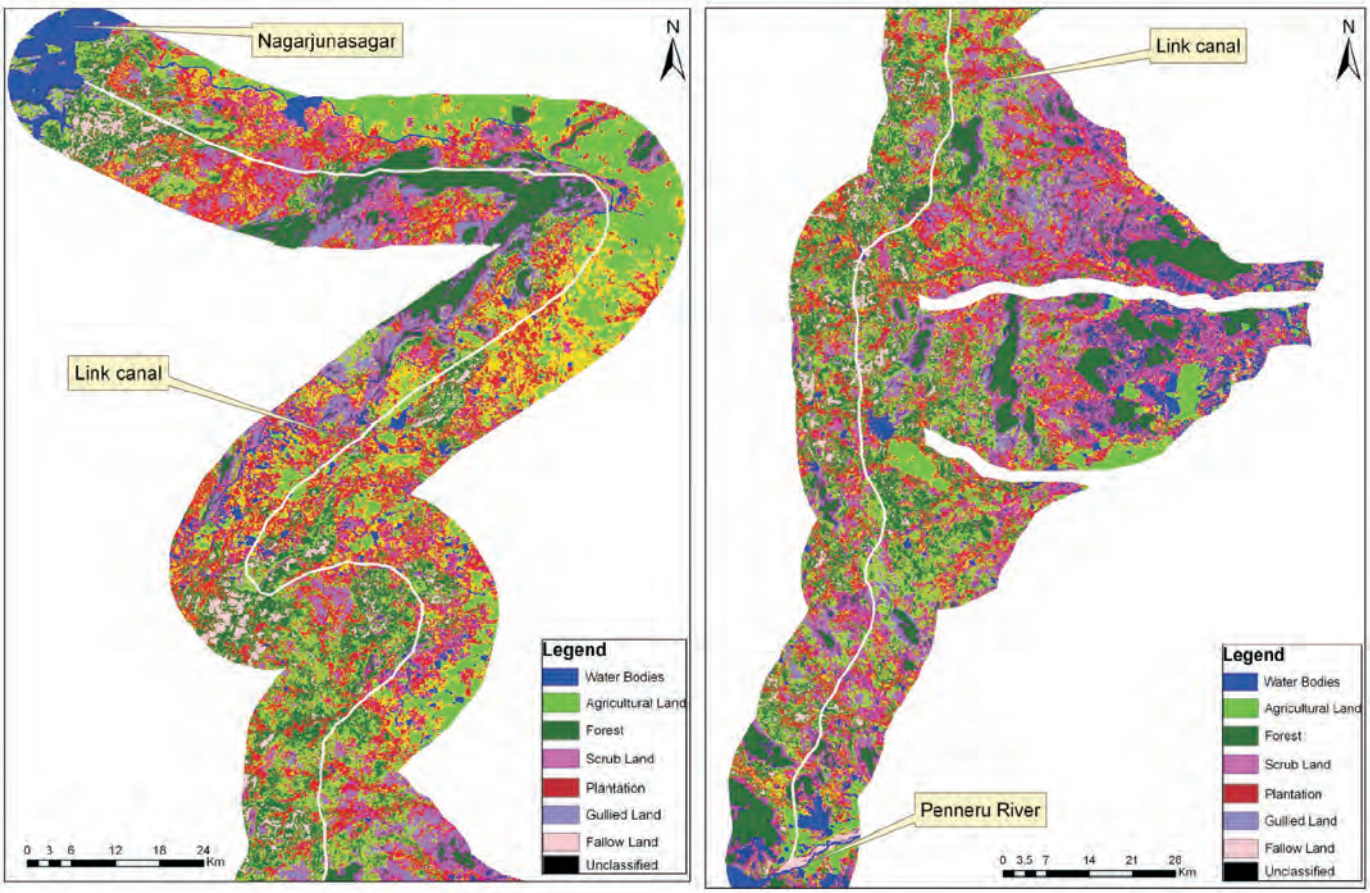


**Figure 5.** Land use land cover analysis.

**Table 3.** Land use / land cover classes of the study area from IRS-P6 AWiFS image.

| Si. No | Class Name | Area (Ha) |
|---|---|---|
| 1 | Water Bodies | 75,069.09 |
| 2 | Agricultural Land | 148,209.5 |
| 3 | Forest | 219,307.3 |
| 4 | Scrub Land | 83,204.6 |
| 5 | Plantation | 87,828.5 |
| 6 | Gullied land | 102,778.3 |
| 7 | Fallow Land | 126,705 |
| 8 | Others | 93,598 |

### Gullied land

The gullies are formed as a result of localized surface runoff affect in the unconsolidated material resulting undulating terrain. The area covered is 102,778.32 ha.

### Fallow land

This class includes barren / rocky / stony waste, mining/ Industrial waste area and sandy area. This fallow land is estimated as 126,705 ha in the study area. Land cover Classification statistics are shown in the Table 3.

Based on the remote sensing study of AWiFS image above, the area occupied by different land use patterns along the alignment is arrived at. The canal alignment passes through fallow lands of Macherla, Velourthi, Durgi mandals on the right side. The area on the right is partly irrigated by NSRBC canal which passes by the side of this proposed canal. From the middle of Durgi mandal canal passes through forest and hill area of Karempudi, Guntur, Piduguralla, Nakarikallu mandals. Beyond this point, it goes through wasteland and hilly area on the right while agricultural lands and wastelands on the left in Ropicherrlla, Ipuru, Savalayapuram,Vinukonda, Bollapalle and Tripurantakam mandals. After Tripuranthakam mandal the area traversed by link canal is scrub land and gullied land on the right and partially crop land on its left up to Dasrsi. After Darsi mandal the canal passes through only wasteland on either side through Podili, Konakanamitla, marripudi, and Kanigiri mandals.

The link canal is traversing mostly fallow land and scrub land in Hanumantunipadu, Veligandla, Chanrasekharapuram, Pamuru, and other 8 mandals in command area. Beyond this point the link alignment passes through similar land type as above up to Dantulur and Marripadu mandals. After Marripadu canal passes through Anantasagaram mandal and joins Srisailam reservoir.

From the above study it is noticed that there are four hilly area mandals where drinking water facility can be met, while 13 mandals occupied with wasteland where complete irrigation facility can be created from the canal.

## ENVIRONMENTAL IMPACT

Environmental impact due to the canal alignment includes positive and negative aspects related to forest, settlements, roads and agriculture lands. One kilometer buffer is created along the alignment to demarcate the villages which are to be rehabilitated on account of canal construction. About 162 villages will be affected along the length of 341 km canal. About 1202 villages will be benefitted by way of drinking water /groundwater recharge and additional irrigation source. Remote sensing study revealed that a large extent of area is under the class of wasteland (229,483 ha) which will be brought under irrigation and additional water to single crop and double crop areas.

The canal passes about 22.5 km. length in Macherla and Veldhurti mandals. In Durgi and Karempudi mandals about 30 km length passes through reserved forest. About 4 km in Ipuru, 3km Bollapalle and 3km in Kanigiri mandal distance is through the reserved forest area. Total about 125 sq km area of reserved forest will be affected due to construction of the canal.

Beyond RD 202.75 km till it reaches the Somasila reservoir, the link canal is criss-crossed by a number of state highways and district roads. The roads connecting Ongole - Kurnool, Kanigiri - Kurnool, Kavali - Badvel and Nellore - Badvel are crossing by the link canal at RD 246.30 km, 265.61 km, 341.92 km and 367.45 km respectively. Besides this, canal alignment also cut across 16 major roads in Guntur district, 22 major roads in Prakasam district, and 6 in Nellore district. Besides this, a number of minor roads and footpaths are traversed by the canal alignment.

The proposed alignment cut across NSRBC at two locations in Guntur district besides number of 1$^{st}$ order and 2$^{nd}$ order drains. In Prakasam district, the link canal traverses Kandleru, Gundlakamma, Markeru, and Munneru rivers and many major and minor streams too. Similarly the canal cut across Pillaperu, Boggeru rivers along with other minor streams in Nellore district.

The link canal passes through 13 km length in Durgri, 26 km in Nakirikallu and 35 km in Ipuru , Bollapalle, Tripuranthakam and Kurichedu mandals in agricultural lands. About 296 sq km area of agricultural land will be affected due to alignment of the canal and also water longing in the above mandals.

## CONCLUSIONS

The study describes the Nagarjunasagar to Somasila link canal, which is one of three links proposed by NWDA, from Krishna to Pennar. The study confined to 10 km buffer area on either side of the alignment and the command area 3252 sq km proposed. The total study area is 9,367.5 sq km. The study revealed that 162 villages, which are fallen in the alignment, will be rehabilitated while executing the canal. About 1202 villages will be served with drinking water / providing irrigation source. IRS-P6 AWiFS Data revealed that a large extent of area is under the class of wasteland (229,483 ha) besides the canal proposed command area of 16,807 ha. The demarcation of the drainage revealed eighteen 5$^{th}$ 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 296 sq km area of agricultural land will be affected in the plains due to alignment of the canal and water longing. Four state

highways and about 40 district roads will be affected due to the canal alignment in three 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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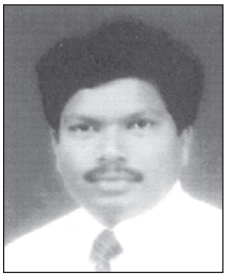
**Dr. B. Surya Prakasa Rao** is presently working as a Emeritus Professor, AICTE in the Department of Geo-engineering, Andhra University College of Engineering, Visakhaptanam. Earlier he was Principal , GITAM Engineering College, Pendurti, Visakhapatnam for 10 months. He obtained M.Sc. (Tech) degree in **Geophysics** from Andhra University 1975. He secured CSIR Senior Research fellowship for his doctoral work and awarded PhD in the Water resources management using Remote sensing techniques in 1983. **Twenty three** students got PhD degrees under his guidance. He published 19 research papers in international journals and 23 in national journals. He is a fellow of IGU and senior member since 8 years in **IEEE, USA**. He was awarded "**Best Researcher award"** form Andhra University in 1995. He was also awarded "**Best Teacher award**" form Andhra Pradesh State Government in 2005. He has completed 6 research projects from various organizations (ISRO, NRSA, MHRD, AICTE, DST, NIRD and CBIP). Presently he is working on, DST project for flood modeling and also working on MOEF Project on Interlinking of Rivers.



**Prof. G. Jaisankar** did his in M.Sc., Geology from Andhra University, Visakhapatnam and M.Tech., ( Remote Sensing and GIS) from IIRS, Dehradun ( Centre for Space Science and Technology in Asia Pacific region-UN centre). He did Ph.D., from Andhra University. Presently working as a Professor& Head of the Department of Geo-Engineering, College of Engineering, Andhra University and he is guiding research scholars for pursuing Ph.D's in Remote Sensing and GIS applications in Earth Sciences. Three students got Ph.D degree under his guidance.

**Dr.V.Venkateswara Rao** retired in August,2009 as Professor in the Department of Geo-Engineering, A.U.College of Engineering, Andhra University. He worked as a Principal, JITM, Parlakhemundi, Orissa, from March 2010 to February, 2011. Presently he is involved doing consultancy projects on "hydrogeological investigations and rainwater harvesting studies" to various industries at all over India. He obtained his Ph.D degree in 1984 in water resources development and management and M.Tech Geophysics degree in 1975. Geophysical and Geotechnical investigations have been carried at 11 proposed inter linking of river projects to NWDA, Govt.of India and are spread all over the country. He has conducted a 6 weeks training programme to the Civil Engineers and Geologists OF Republic of Afghanisthan, Kabul on groundwater exploration and management during the year 1983-84 under UNICEF Programme. He is a pioneer in developing the designs of roof water harvesting since 1990 and influenced the common man to accept the technology. He was member, Rajiv Gandhi National drinking Water Mission, Ministry of Rural Development, Govt. of India during 2002-2004.
He has Published 46 research papers in national and international journals. Eight students got their Ph.D degrees under his guidance. More than 100 M.Tech students submitted their dissertations. He has completed 4 research projects funded by DST, ISRO and NRSA. Presently he is carrying out the project 'hydrogeological studies in and around Kolleru lake' funded by DST, New Delhi.

**Dr.E. Amminedu** was born in 1955 and is presently working as a Professor in the Department of Geo-Engineering, College of Engineering, Andhra University, Visakhapatnam. He was also the former Head of the same Dept. He published 23 scientific papers in National and International Scientific Journals and contributed 15 papers in Seminar proceedings. He has guided more than 30 students for their M.Tech. thesis and 2 students for their Ph.D. thesis. He has been working since last 20 years in the field of river basin studies. His present research interests are application of Remote Sensing & GIS in the fields of 1) Watershed management 2) Environmental studies of lakes and reservoirs 3) Linking of river systems 4) Hydrological modeling.

**Dr. P Kesava Rao** presently working in National Institute of Rural Development, Hyderabad as Assistant Professor at Centre on Geo-informatic Applications in Rural Development. He did his B.E (Civil Engineering) from Osmania University, M. Tech (Remote Sensing) from Andhra University and Ph. D (Remote Sensing) from Jawaharlal Nehru Technological University, Hyderabad. He has 19 years of Teaching, Research, Consultancy and Training Experience. After his M. Tech he has worked in JNT University, Hyderabad for 13 years. Since then he has guided more than 35 M.Tech/MSc theses. Presently he is guiding 5 Ph.D Scholars on Geo-informatic Applications on Rural development and Agriculture. Presently he is working on Watersheds, ICT, SDSS for Rural Development, Agro-climatic Planning and Information Bank (APIB), Rural Roads and Land Information Systems