No. NRSC/RSAA/03-2015

BRIEF REPORT

REMOTE SENSING BASED FEASIBILITY EVALUATION

of

MULTI RURAL VILLAGE WATER SUPPLY SCHEME: BAGODA, M.P.

JANUARY, 2015

NATIONAL REMOTE SENSING CENTRE

INDIAN SPACE RESEARCH ORGANISATION

DEPT. OF SPACE, GOVT. OF INDIA

HYDERABAD-500 037

1. Background

A multi village rural water supply scheme has been proposed in and around the village of Bagoda in Vidisha District of Madhya Pradesh. As per the proposal provided to NRSC, around 35 villages of the area are to be connected through a pipeline grid, which involves a main pumping route and accessory gravity flow driven routes (**Figure 1**). Further, the distribution grid is divided into two zones (**Figure 1**) which are connected to a intake well and reservoir (Rehti Dam) via a water treatment plant. The planning of the pipeline distribution grid has been carried out using Survey of India, toposheets and preliminary ground survey.

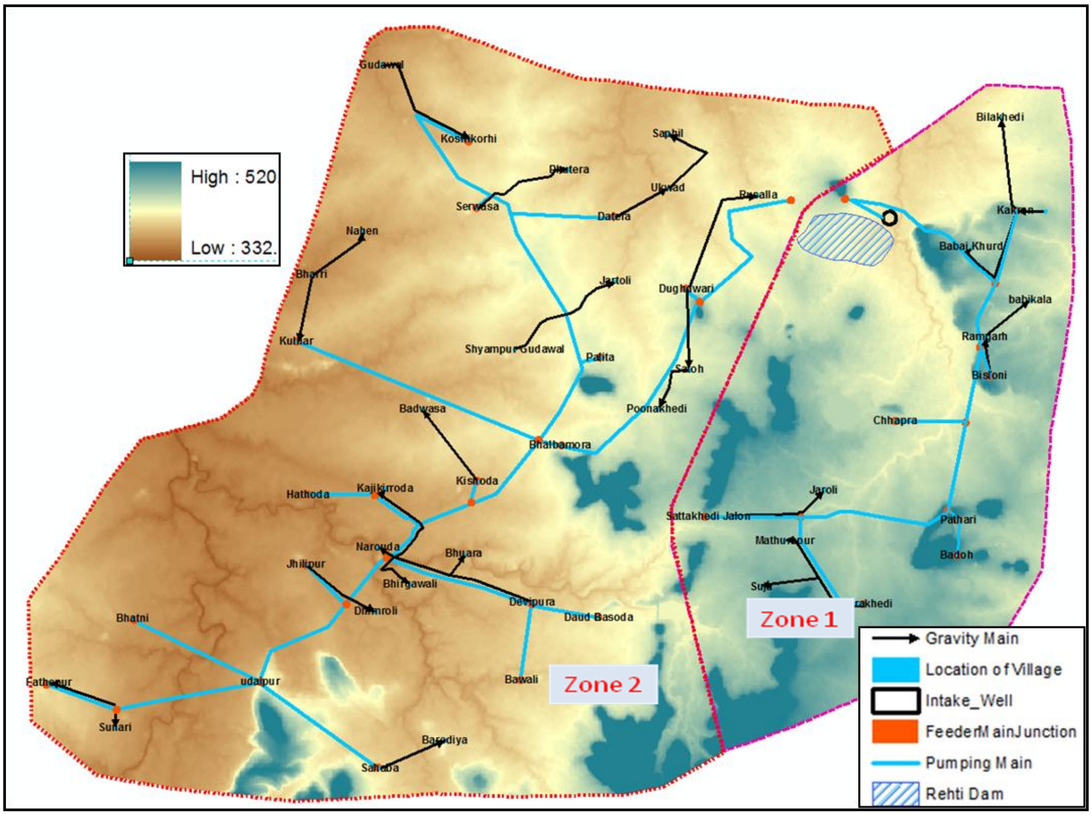

Figure 1. Overview of the proposed pipeline grid (overlain on CartoDEM, elevation in mts)

National Remote Sensing Centre (NRSC/ISRO), Hyderabad was instructed by Secretary, Ministry of Drinking Water and Sanitation, Government of India, to make a comprehensive assessment of the proposed pipeline distribution grid in order to validate its feasibility and further optimize the same, using satellite derived thematic data and topographic information from stereo images. Further, it was also desired to substantiate if this type of water pipeline grid planning and optimization, at an initial stage, can be carried out using space based inputs. Accordingly, a brief study was taken up by NRSC on the following broad guidelines.

2. Objectives

In accordance to the background requirements, as mentioned above, NRSC took up the activity, with the following broad objectives:

- To make an assessment of the feasibility of the proposed pipeline grid using the following:
  - ➢ Topographic information from digital surface model, derived from CARTOSAT 1 stereo images.
  - ➢ Geomorpholgical and land use information derived from satellite images.
- To suggest any further optimisations based on the observations as mentioned above.

3. Study Area

As seen in Figure 1, the entire area comprises of around 35 villages within the Vidisha District of Madhya Pradesh. Hence, given the extent of the study area vis-à-vis the time frame of the current assessment activity, it was decided, that the evaluation will be carried out within zone 1 only. The area falls within the SOI toposheet no. 55I/01 with a small portion within 55L/04 towards the north.

4. Remote Sensing Data

The following Remote Sensing data in the form of topographic information and thematic layers derived from satellite imagery ways used.

4.1. **Topography information:** For this, Cartosat-1 digital surface model at 10m spatial resolution was used.

4.2. **Geomorphological information:** This was derived using the Geomorphology thematic layer produced from the National Geomorphology and Lineament Mapping (NGLM) project carried out in NRSC. The base satellite imagery from Resourcesat-1 LISS III and scale of mapping is 1:50000 were used.

4.3. **Land use information:** The Landuse / Landcover maps derived from Satellite images are used. Ancillary information like drainage and other details were also incorporated as required. These thematic layers are available on Bhuvan Geoportal (www.bhuvan.nrsc.gov.in) of NRSC also. The data used is summarized as below (**Table 1**)

Table 1. Summary of dataset used

Input	Source	Base Satellite imagery	Resolution	Scale
Topography	Carto-DEM	CartoSat 1A	DEM: 10 m	-
Geomorphology	NGLM	RS1 LISS III	23.5 m	1:50000
Land Use	LULC 1st Cycle	RS1 LISS III	23.5 m	1:50000

5. Analysis and Observations

The hardcopy maps of the proposed pipeline grid was geo-referenced to bring them to the same spatial reference as of other GIS layers. Further, the entire pipeline gird along with locations of villages etc., were vectorized, so that overlay analysis can be carried out on GIS platform

The assessment was carried out in the following manner:

5.1. Topographic assessment:

Elevation profiles were derived along and across (N-S and E-W) the area, to understand the regional slope. It is seen that, regional slope is from south to north and from east to west. The main pumping line of the grid flows from north to south opposing the natural slope and does not pass through any major escarpments (**Figure 2**). Further, the intake well has been planned at a topographic low.

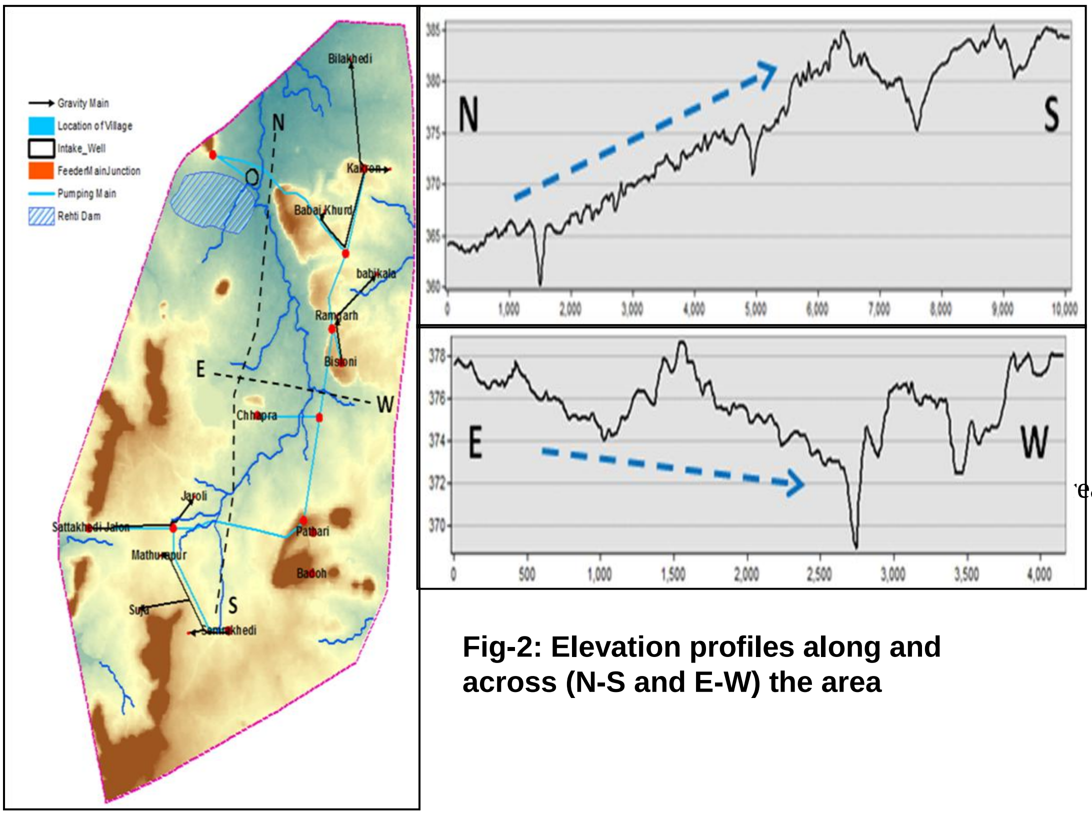

Fig-2: Elevation profiles along and across (N-S and E-W) the area

- To assess the feasibility of the gravity flow driven pipelines, the grid was divided into 3 sectors with a central node at each sector, from which the flow would commence (Figure 3).

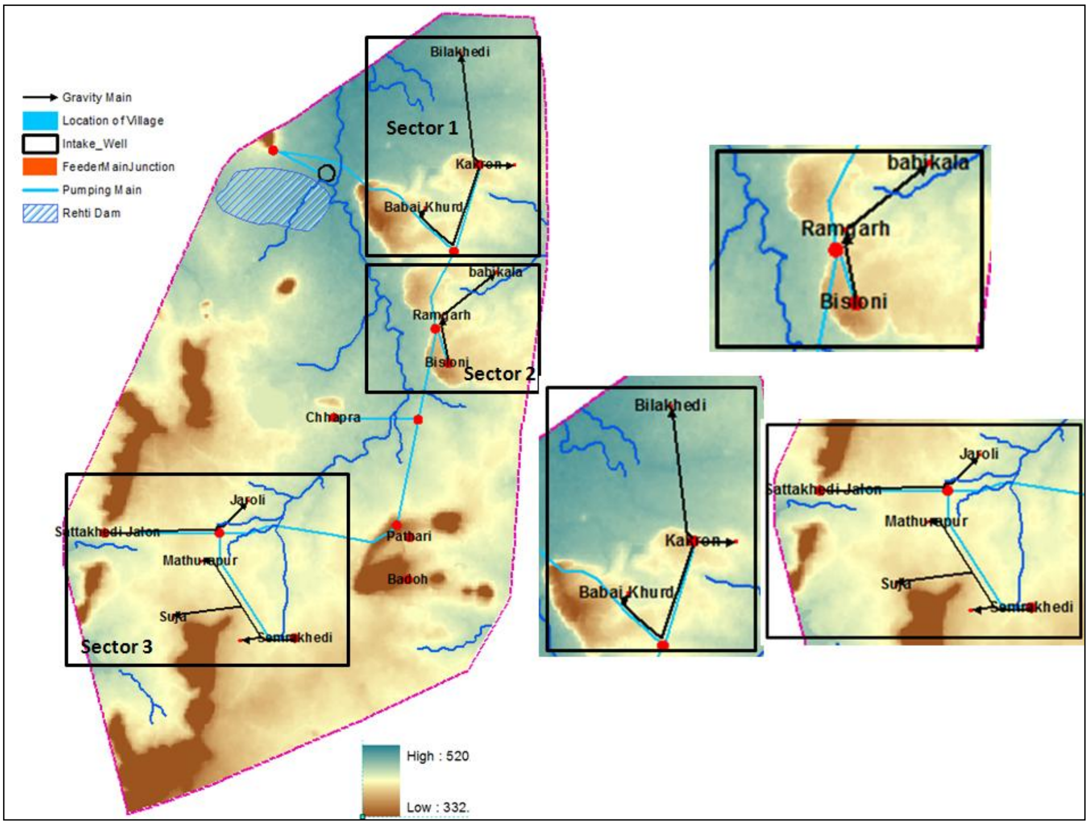

Figure 3 . Gravity driven routes in 3 separate sectors with central nodes at Kakron, Bisoni and Semrakhedi respectively

- Elevation profiles were taken from the DEM along these gravity driven pipelines of each sector (as shown in **Figure 3**) to verify feasibility of flow with respect the slope along which they are planned to be built.
- It is seen that in sector 1 (Kakron and surrounding areas), all the gravity driven pipelines are planned down slope to terminal points (marked as 1, 2 and 3 in **Figure 4**).

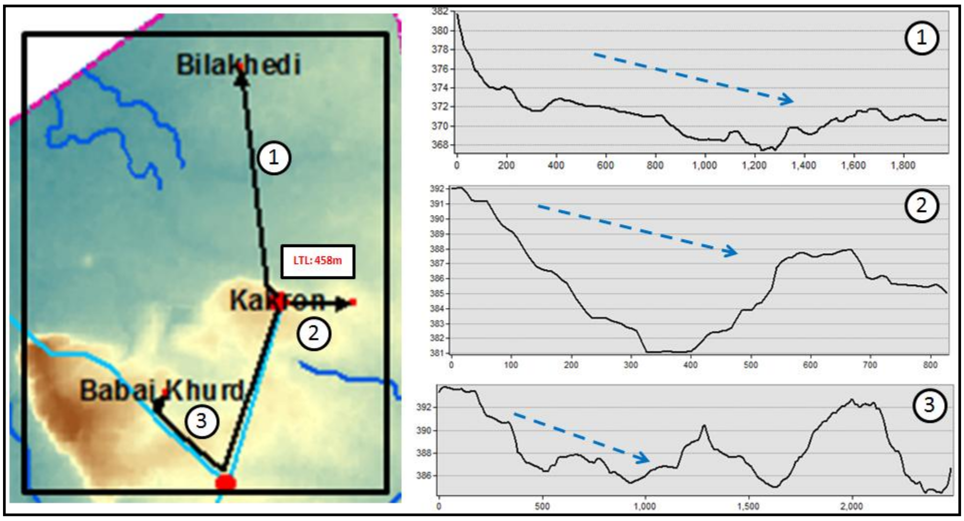

Figure 4. Gravity flow network and topography in Sector 1

- Therefore, in this area, the flow will be aided by the natural slope of the terrain. However, lines 2 and 3 may confront a minor scarp section (Figure 4). Further, an overhead tank proposed at Kakron with a water level (LTL) of 458 m (as seen in the toposheet) will create a hydrostatic gradient sufficient to sustain the flow.

- Similarly, the sector 2 (Bisoni and surrounding areas), both the proposed pipelines (marked 1 and 2 in Figure 5) flow down slope and hence can sustain flow by means of gravity.

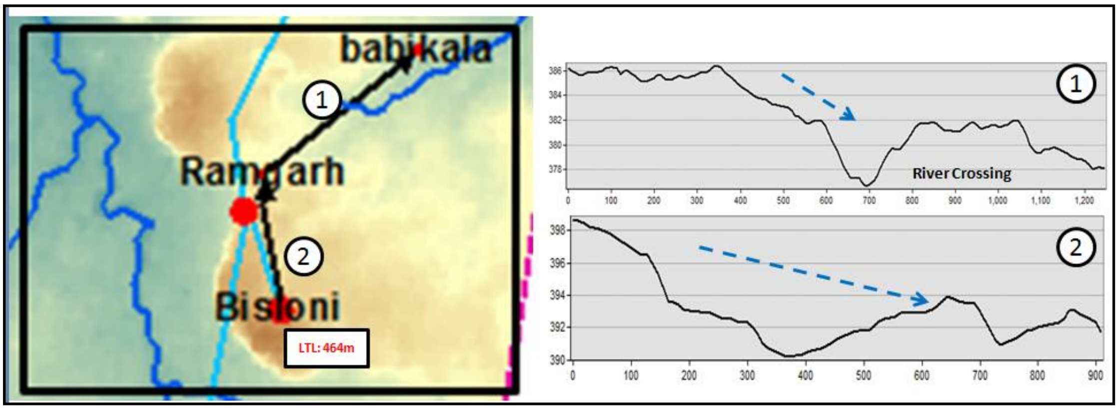

Figure 5. Gravity flow network and topography in Sector 2

However, it may be noted that line 1 may confront a small stream crossing, which has to be managed adequately. The overhead tank at Bisoni will have an LTL of 464 m (as seen in the toposheet) and will create a gradient which is sufficient to sustain flow.

- Finally, in sector 3 (Semrakhedi and surrounding areas), the key observation is that all the planned gravity driven pipelines flow against the local slope (marked as 1, 1A, 1B and 2 in Figure 6). Hence, un-aided natural flow will be hindered. Further, in comparison to the other sectors, the terrain in this area is more undulatory.

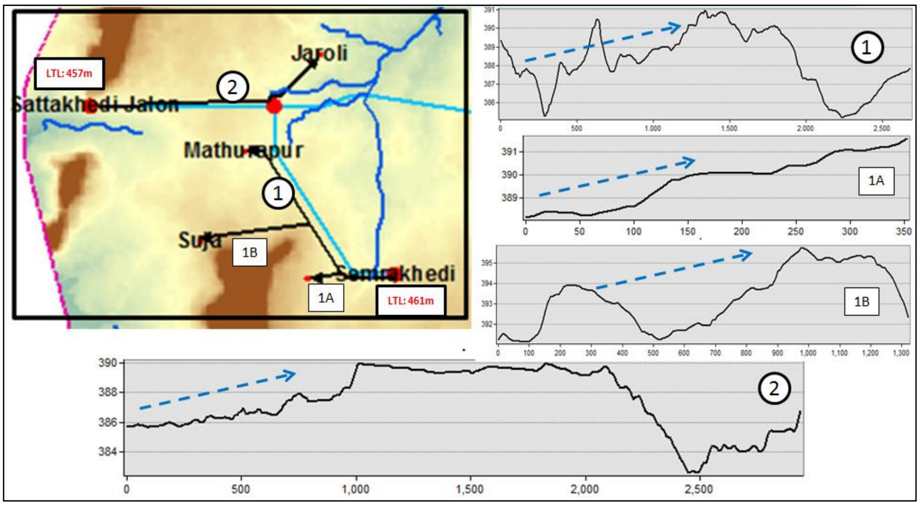

Figure 6. Gravity flow network and topography in Sector 3

Therefore, to counter-act this issue and sustain the natural flow, two high overhead tanks are proposed at Sattakhedi and Semrakhedi (LTL of 457m and 461m respectively) to create a steep hydrostatic gradient and maintain flow continuity. By using these tanks, the effect of the topography can be neutralised.

- The DSM based analysis is very much in accordance to the observations made using Survey of India (as provided by MDWS)

5.2. Geomorphological assessment:

- To assess the effect of geomorphology of the area, the pipeline network vector was overlaid on the geomorphology layer (Figure 7a).

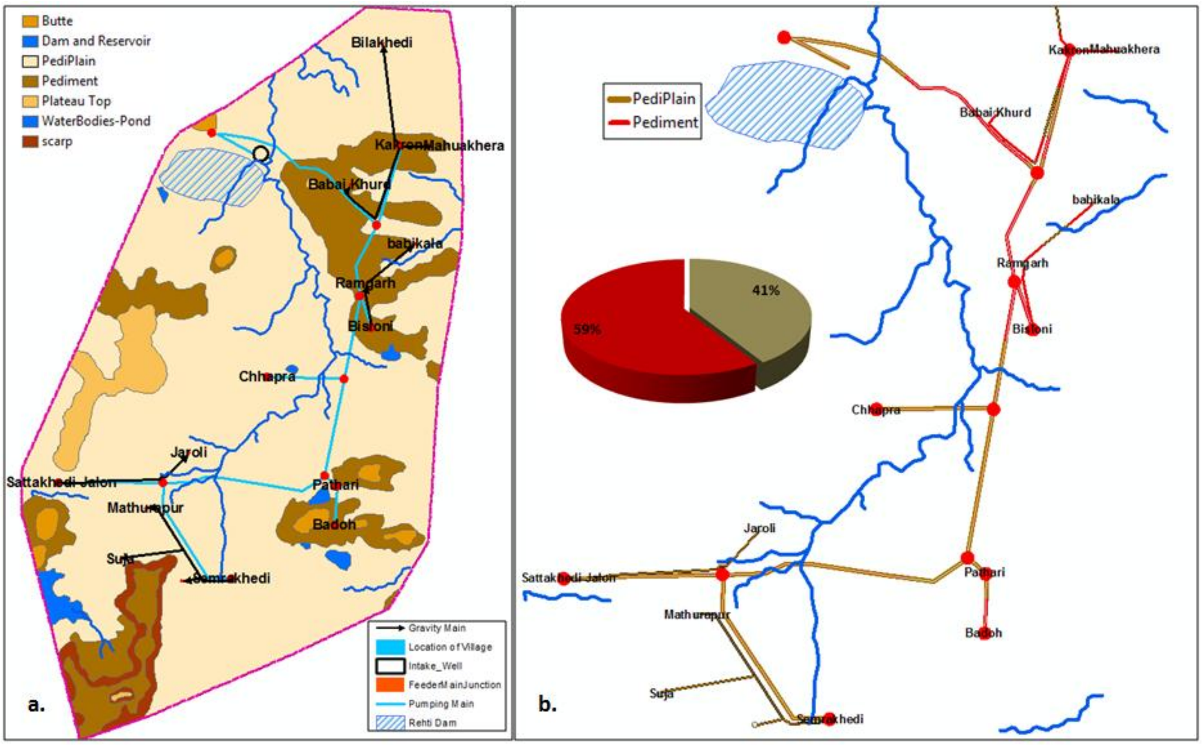

Figure 7

(a) Pipeline grid overlain on geomorphology thematic layer;
(b) relative percentages of pipeline length in particular geomorphologic features

- Also, to estimate the relative percentages of pipeline length in particular geomorphologic features, the pipeline vector was spatially intersected with the geomorphology layer. It is seen that the entire length of pipeline is along a pediment / pediplain area. 41% of the pipeline length is within pediplain and the remaining 59% is within pediments. Further, there is no geomorphological hindrance (scarps, mounds etc.) which can cause obstructions along the length of the pipeline. Hence there may be no requirement of major excavation

5.3. Land-use assessment:

- To assess the effect of the proposed pipeline grid on the existing land-use in the area, the pipeline grid vector was overlaid and intersected with land-use/land cover layer, similar to that done for the geomorphology layer (Figure 8 a. & b)

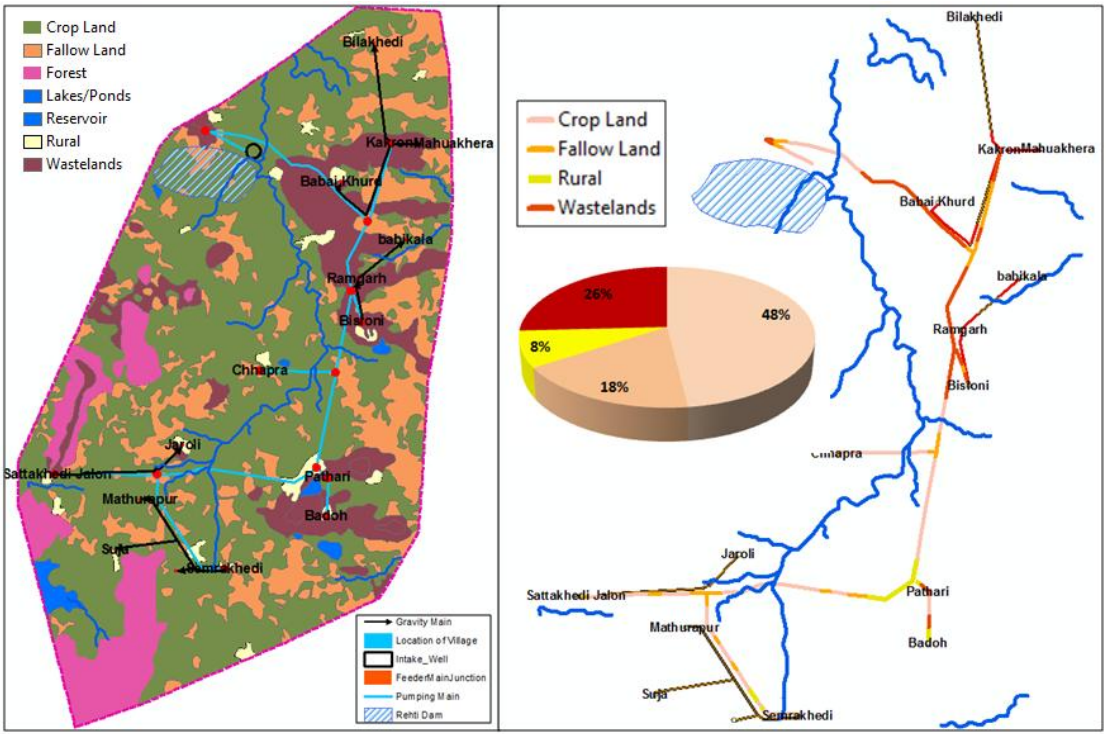

Figure 7

a. Pipeline grid overlain on Land-use thematic layer

b. relative percentages of pipeline length in particular land-use features.

It is observed that the pipeline is routed mostly through existing croplands and wastelands with 48% of the pipeline length passing through croplands and 26% through wastelands. There is a need to optimise further on the pipeline passing through cropland and private land to arrive at the best possible routing and for economics. This could further be done using cadastral maps and other high resolution images, as required.

6. Summary and Recommendations

6.1. Summary

The assessment can be summarized as follows:

- The intake well (source) is optimally selected at **topographic low** to facilitate easy draw-down.

- Main pumping line against regional slope is taken into consideration, to **optimize** on the energy assisted flow.
- Gravity driven lines are generally made **down-slope**; Where ever slope opposes flow, high overhead tanks are proposed, to create hydrostatic gradient to ***neutralize*** effect of topography.
- Entire pipelines are routed through **pediplain-pediment** area, hence there are no geomorphological hindrances.
- Pipelines are planned in such a manner that it **minimizes** any **negative impact** due to existing **land-use** practices

6.1 Recommendations

From the assessment of Zone-1 of the proposed pipeline grid, the following recommendations are made:

- The proposed pipeline routing carried out by the above sighted study, using SOI topo-sheets, for given study area (Zone 1) is optimal - as per the requirements. The incremental value addition, for any further optimization, using the space based inputs, will be minimal.

- However, information from satelilite images and other derived thematic layers like digital surface model, geomorphology and land use from satellite data, can be effectively used for pipeline routing and optimization.
- The entire exercise could be completely done on a GIS based decision support system, rather than manual methods. This will enable inclusion of many parameters while decision making like, existing land use / land cover, Digital Surface models at 10 m placement, existing drainage network, settlements, census information etc.
- It is recommended that the feasibility analysis be done through GIS-based system, so that multiple teams in a short time could cover larger areas. NRSC proposes to provide necessary support through Bhuvan Geoportal for carrying out such activities by MDWS at National scale.
