Fallow Land Mapping –Remote Sensing and GIS Applications

S. Chattaraj, V. Ramamurthy, D. Mohekar, P.S. Butte and S.K. Singh

3.1 Introduction

In the 9 fold classification of land use, fallow lands are classified into three categories viz. Current fallow lands (CFL), fallow land other than current fallow (FLOCFL) and culturable waste lands (CWL). CFL represents those cropped lands which are kept fallow during the current year, whereas FLOCFL includes other fallows kept out of cultivation temporarily for a period of not less than one year but not more than five years. The other category of fallow land, CWL includes land available for cultivation, but not cultivated during the last five years or more in succession for some or other reasons. In 1950-51, fallow lands accounted for about 24 thousand ha comprising 17445 thousand ha FLOCFL and 10679 thousand ha CFL. In 1982-83 about 23636 thousand ha of land were classified as fallow lands, accounting for 7.8% of the total area of the country. Andhra Pradesh alone occupied 15.5% of the total fallow lands whereas Punjab accounted for only 0.01% of fallow lands in the country.

3.2 Technology Development

A technology consisting of Multi seasonal and multi temporal and historic remote sensing data has been attempted to delineate various kind of fallow land in the year 2014-15 for the state of Goa as a case study. The flow chart (Fig. 3.1) explains the overall methodology for fallow land mapping. In the first step, IRS-R2-LISS-IV P6 data of 5.8 meter resolution of 2014-15 and high resolution google earth imagery of 0.5 meter resolution available in public domain are interpreted visually to derive the land use/land cover of the Goa state on 1:10000 scales (Fig. 3.2).

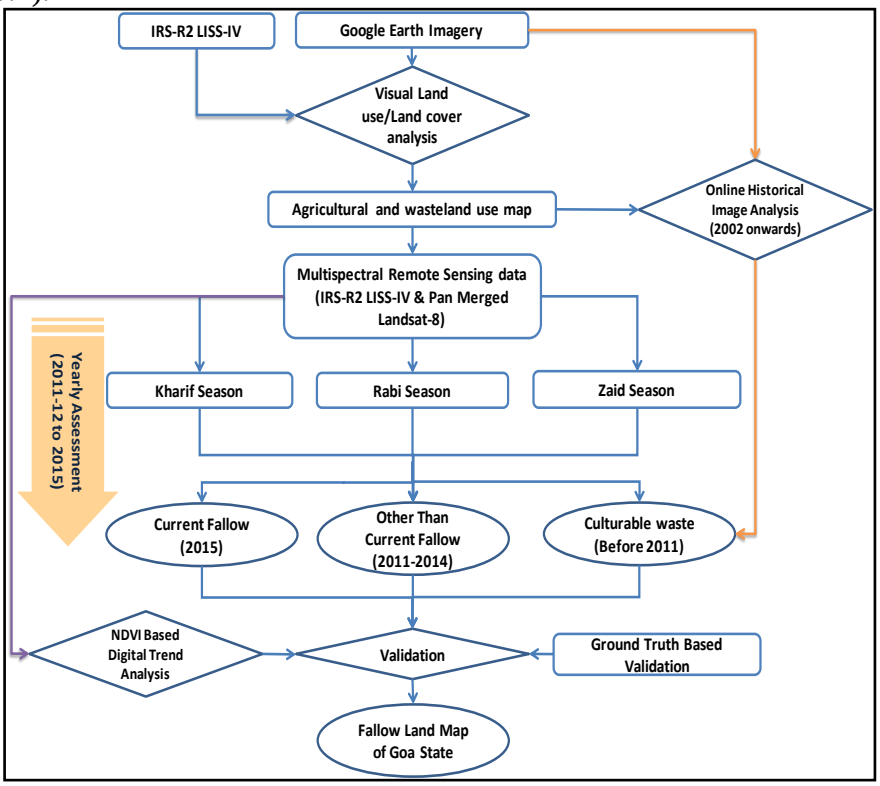
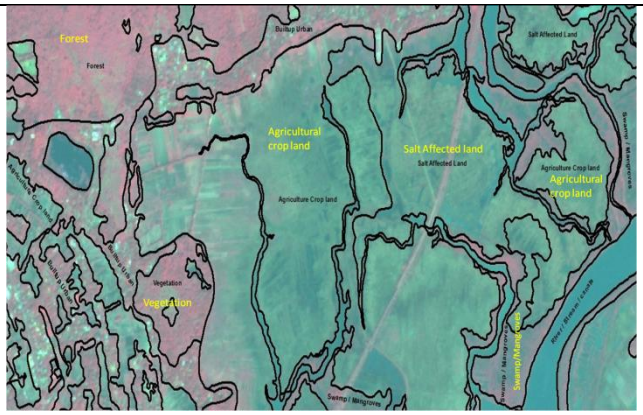


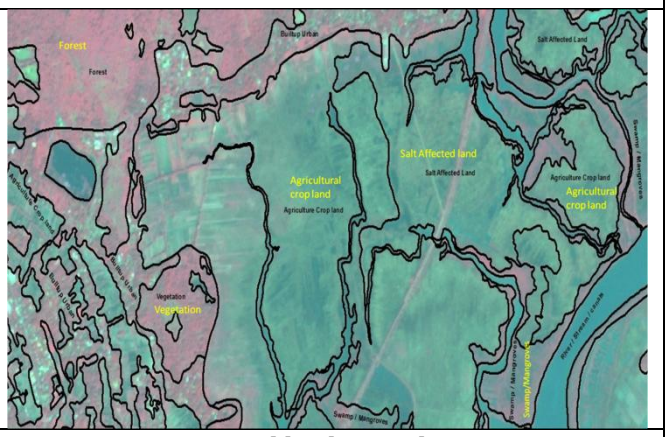
Fig. 3.1. Methodology flow chart for delineation of fallow lands

GeoEYE data



Extracted land use polygon

LISS IV P6 data



Extracted land use polygon

Fig. 3.2. Interpretation of remote sensing data for land use and land cover mapping

The current fallow lands (CFL) are delineated using the False Color Composite (FCC) of multi seasonal data of LISS-IV P6 and Landsat-8 of 2015. The Pan-sharpened Landsat-8 data of 15 m resolution was used in place of LISS-IV for Kharif *season* at places in absence of cloud free data. The lands with field boundary in agricultural land uses and without field boundary in the wasteland were identified as agricultural and fallow land in the 1st phase.The agricultural lands with field boundary were relooked at larger scale for continuously lower spectral response in NIR region i.e. the redness in terms of FCC. Those land parcels which show redness below the user defined threshold in all the three seasons namely Kharif, Rabi and Zaid of the current year i.e. 2015; were demarcated as current fallow lands (Fig 3.3).

Kharif 2015

Rabi 2015

Zaid 2015

Fig. 3.3. Interpretation of current fallow lands using multi seasonal data

Problem of separating similar spectral response of grass and cropland in certain patches of current fallow lands were done by trend analysis of time series data of Normalized difference vegetation index (NDVI) (Fig. 3.4). This kind of digital validation was done for reconfirming the spectral response of cropland and patches of grass lands. Higher the value of NDVI better is the growth of vegetation. The basic difference between a cultivated crop and grass species are the growth stage specific enhancement in NDVI values due to the increased crop cover throughout the main growing season. Hence, if we plot the NDVI values of cropped field against the months of growing period, there will be a sharp rise in the NDVI values in crop lands as compared to the CFL. Sharp rise of NDVI for crop land and near parallel NDVI for portion of grass in the shady cover area in fig. 3.9 confirms the observations.

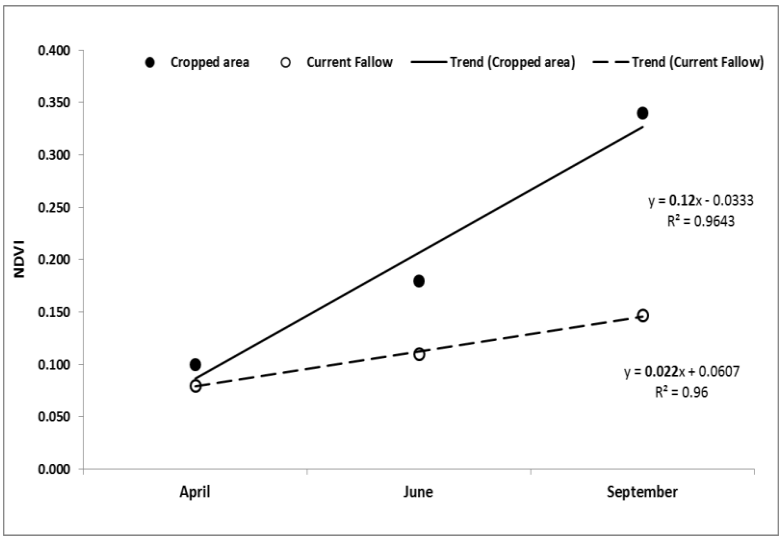


Fig. 3.4. NDVI based digital trend analysis for identification of fallow lands

Three growing season images of each year from 2011 to 2014 were visually checked in wasteland polygons of 1st phase LULC layer to map FLOCFL in the state. The idea behind taking the exercise in the wastelands for searching the FLOCFL is based on the hypothesis that in a time span of five years, many of the previously cultivated field boundaries are supposed to loose the smooth texture and checker board pattern of bunds, may, therefore, start appearing as wasteland in the recent year of 2015. To differentiate these landform wasteland polygons, the decision of relooking the wasteland polygons was made. The online google earth image based searching of FLOCFL in the wasteland polygons was also carried out simultaneously (Fig. 3.5a&b).

Fig. 3.5a. Interpretation of fallow land other than current fallows using temporal data

Part of Goa, FLOCFL, 2011	Part of Goa FLOCFL 2015

Fig. 3.5b.Interpretation of fallow land other than current fallows using temporal data

The area other than FLOCEL in the waste land is CWL which is defined as the land out of cultivation for a period of five years or more.

Swamp and mangroves are delineated using public domain google earth imagery. The online google earth imagery is having a historical database available from the year 2002 onwards. It is seen during the analysis that the land parcels which are showing clear patches of cultivation before 2011 and those went out of cultivation after 2011 and are presently covered under scrubs, swamps or mangroves (Fig. 3.6). This is confirmed by using geo-referenced cadastral maps. The lands have the survey numbers in the cadastral map but are covered under swampy, marshy or mangroves; also classified under this category of waste lands. Extensive GPS-based ground truthing is done with the estimated fallow land map for verification in the field level. The larger and major polygons of fallow lands are visited during the field survey and necessary post field corrections are also made. The observations are further verified by extensive ground truthing.

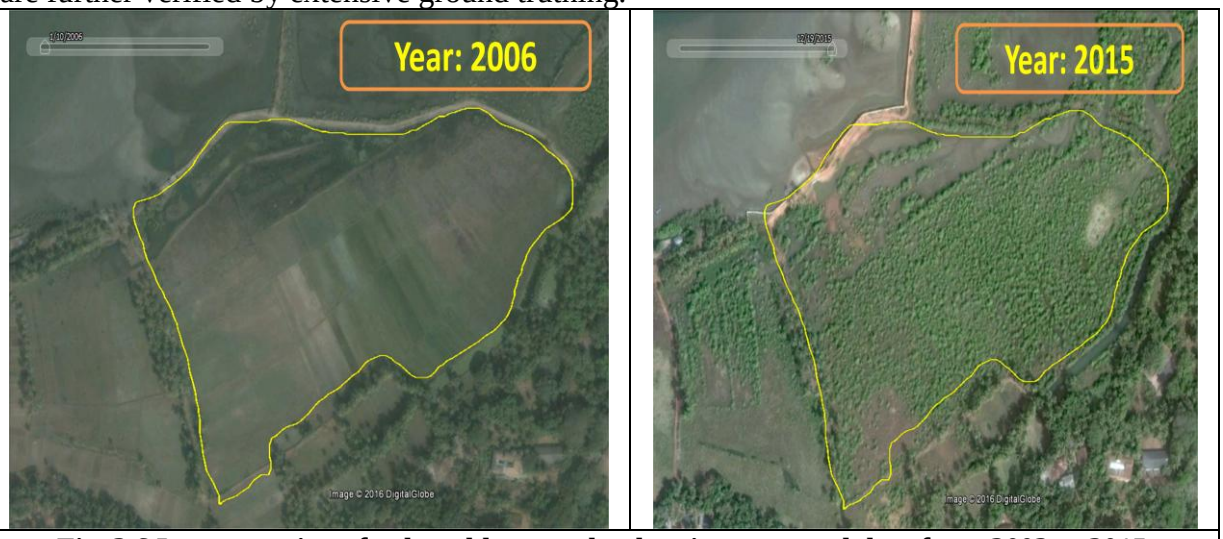


Fig. 3.6.Interpretation of culturable waste lands using temporal data from 2002 to 2015

3.3 Up scaling the technology for mapping fallow lands of Goa

Based on the described scheme, fallow land in the state of Goa is mapped.The results reveals that fallow lands cover 13408 ha area in Goa, constituting 3.6% area of the state. The current fallow lands (CFL) cover 4707 ha (35.1% of the total fallows in the state and 1.27% of total area of the state); culturable waste lands (CWL) are 4781 ha (35.7% of the total fallows in

Goa and 1.28% of the total area the state) and fallow lands other than current fallow (FLOCFL) cover 3920 ha (29.2% of the total fallows in Goa and 1.1% of the total area of the state) (Table 3.1, Fig. 3.7 and 3.8).

Fallow lands in north Goa cover an area of 9344 ha (69.7% area of total fallows of the state and is comparable to 9.9% of the total net cropped area of north Goa) and 4064 ha area in south Goa (30.3 % area of the total fallows of the state, corresponding to 6.4 % of the total cropped area of south Goa) (Fig.3.9).

Taluka wise distribution indicated that fallows are the highest, on 3732 ha area in Tiswadi and the lowest in Satari on 74 ha area. CFL is the highest, covering 1453 ha area (30.9% of CFL of the state) in Bardez and the lowest in 8 ha area (0.2 % of CFL of the state) in Satari. CWL is the highest in Tiswadi covering 1491 ha area (31.2% of CWL of the state) and the lowest in Sanguem on 37 ha area (0.8 % of the CWL of the state). FLOCFL occupies the highest area of 977ha (24.9% of FLOCFL) in Salcet and the lowest on 6 ha area (0.2 % of FLOCFL in the state) in Satari. For the better communication with the farmers, fallow land maps of panchayat has been attached with the cadastral maps.

The study further claims that fallow land in Goa is equal to its 10.3% area used for food crops, 8.5% of total area sown for other field crops, 33.3% of the gross area under rice, 124% of the area under other cereals, pulses and other oilseed crops, 22.5% of the total area under different cash crops of the state including cashewnut, aracanut, pepper, tree species, kokum, sweet potato and sugarcane, 117% area of the garden crops, 186.4% of the area of the vegetable crops, and 50.3% area of the non-food crops. Thus the data obtained using remote sensing technique is slightly higher than the data collected by the revenue department. That confirms the versatility for mapping procedure and could be replicated elsewhere.

Further the attempt has been made to understand the reasons of fallowing in Goa. The pattern of fallowing in the state suggests that these are located dominantly in the Khajan lands known for high productivity of rice. "This is an area which time and again is affected by seawater and fresh water of river Zuari and Mondavi draining the state from hills to the coasts. The Khajan lands of Goa have unique system of water regime consisting of fresh and sea water during Kharif season. This is the essence of high productivity of rice in Khajan lands. The study further claims that the Mondovi and Zuari rivers the life line of the state and draining Goa from Ghats to sea. The increasing sediment load due to excessive erosion in the Ghats and extensive mining in the catchment disturbs the uniqueness of water regime of Khajan lands and makes the agriculture non-remunerative and non-profitable. This is perhaps one of the reasons for increasing fallow lands in the recent years.

Table 3.1. Taluka wise distribution of fallow lands in Goa state

Taluka	CFL	FLOCFL	CWL	Total
Tiswadi	1377 (29.3)	864 (22.0)	1491 (31.2)	3732 (27.8)
Bardez	1453 (30.9)	871 (22.2)	794 (16.6)	3118 (23.3)
Bicholim	322 (6.8)	340 (8.7)	269 (5.6)	931 (6.9)
Pernem	650 (13.8)	258 (6.6)	581 (12.1)	1489 (11.1)
Satari	8 (0.2)	6 (0.2)	60 (1.3)	74 (0.6)
Ponda	74 (1.6)	195 (5.0)	277 (5.8)	546 (4.1)
Canacona	97 (2.1)	235 (6.0)	71 (1.5)	403 (3.0)
Dharbandora	28 (0.6)	19 (0.5)	58 (1.2)	105 (0.8)
Murmgao	9 (0.2)	102 (2.6)	190 (4.0)	301 (2.2)
Salcete	499 (10.6)	977 (24.9)	876 (18.3)	2352 (17.5)
Sanguem	124 (2.6)	29 (0.7)	37 (0.8)	190 (1.4)
Quepem	66 (1.4)	24 (0.6)	77 (1.6)	167 (1.2)
Total	**4707**	**3920**	**4781**	**13408**

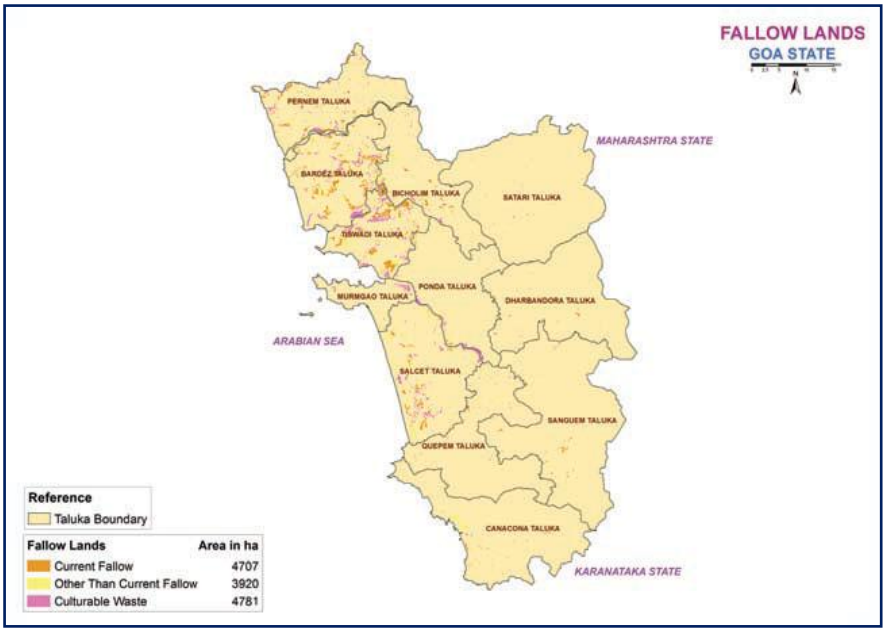


Fig.3.7. Spatial distribution of fallow lands in Goa state

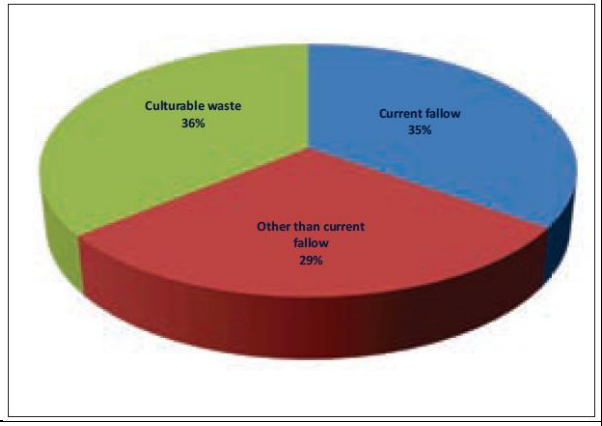


Fig. 3.8. Different categories of fallow lands in Goa state

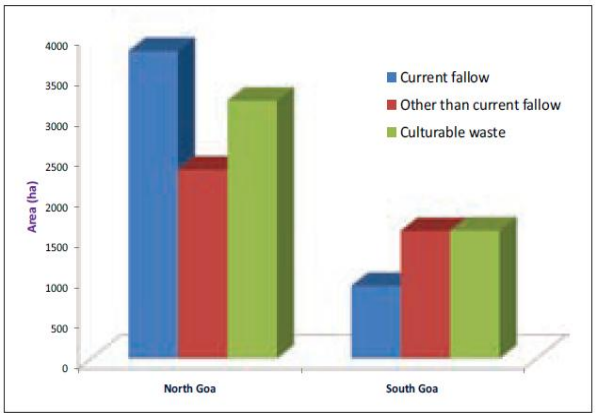


Fig. 3.9. Different categories of fallow lands in North and South Goa districts

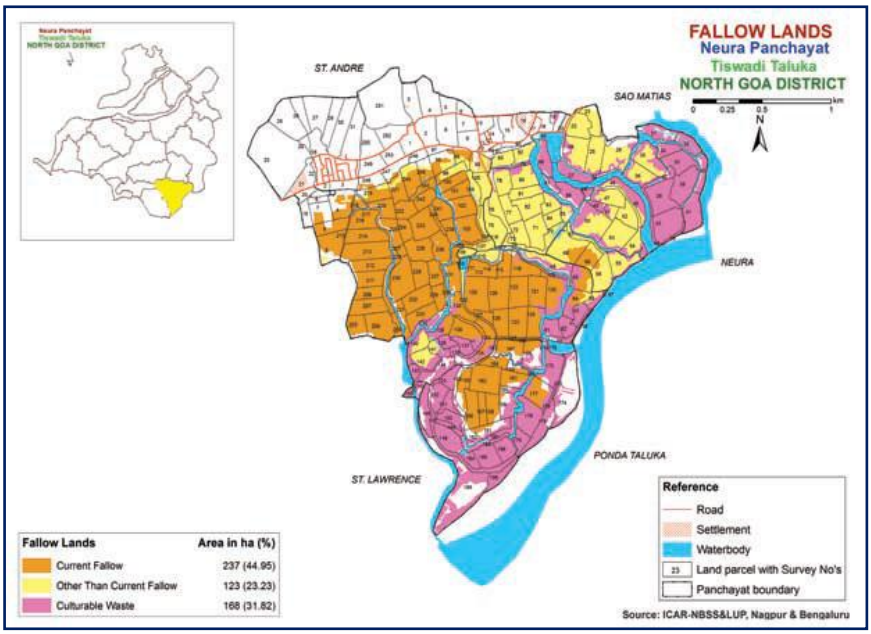


Fig. 3.10. Spatial distribution of fallow lands in Neura panchayat, Tiswadi taluka

3.4 Summary

The study reveals that application of multi-seasonal, multi-temporal and historic remote sensing data is very useful for defining the extent of fallowing and also helpful in finding out the reason of fallowing. For instance, in the state of Goa, estuary developed by the Mondovi and Zuari rivers draining the state of Goa from Sahyadri hills to the coastal plains, used to bring sediments from the mining area located in the catchment. The sediment of the river disturb the equilibrium between the fresh and sea water of Khajan lands that makes the agriculture non-remunerative on the part of very fertile land of Goa for paddy.The study further opens to new corridor for mapping and characterizing the vast area under paddy–fallow system of eastern and north-eastern region that is expected to help for making agriculture as a profitable proposition.