CHAPTER - IV

METHODOLOGY - INCLUDING
APPLICATION OF REMOTES
SENSING IN SIRUMALAI FOREST
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Methodology Approach

The present Research and Study is Combination of Analysis of Secondary Data relating to historical perspective, policy changes, management approach and strategy affecting natural resource status and also by interpreting satellite data on Changing Natural Resource status complemented by gathering of ORIGINAL data on Socio-Economic groups, their differing relationship with forest produce, their perception, utilisation, ecological histories and management options through a structured socio-economic field survey of select variables relevant to the objectives of study.

Through this primary data all the necessary data related to deforestation and social responses including the DETERMINANTS such as livelihood needs, demand and supply compulsions market - forces, particularly the socio-economic perspectives having a bearing on natural resource management and other relevant aspects have been considered.

The primary data focus is more on the present / current pattern, situation, differentials and determinants of the problem on the basis of economic aspects in the study area at hamlet level.

Three streams of action were adopted:

A. A critical analysis of secondary data on Sirumalai Forest Area available at Archives, erstwhile Board of Revenue, the Office of the Chief Conservator of Forests, Chennai, District Forest Officer, Madurai District Gazetteer (several editions), season and crop reports (series published by Government of Tamil Nadu), Swedish International Development Agency (SIDA) aided Social Forestry reports, Forest Manuals, Official Orders, Circulars etc.;

B. Use of available Remote Sensing Data /SOI Sheets to study Changing the Forest Cover in Sirumalai Hills. Gathering Satellite images of the area under study from National Remote Sensing Agency (NRSA), the various satellite data was interpreted using digital methodology.
C. By a designed Socio-Economic Field study appropriate to varying study sites
to analyse the Forest Resource status causes of deforestation and evolution of

A. First Set of Data from (Government Sources) / Government Archives

List of Books / References consulted in Archives for gathering data and information
on the historical perspective of forest management in India as well more
specifically about Madurai District and Strumalai Hills Forest

(1) Forest Administration in Madras Presidency - D. Brandis, 1883; (2) Forests and
Gardens of South India, 1861 - Hugh Cleghom, Conservator of Forests, Secretary to
Government of Madras, Fort St. George (JB 21 M61-48443; (3) Statement of Forest
Conditions in British India - British Empire Forestry Conference, London, 1920; (4)
Report on the Proceedings of Forest Conference held in Simla, October 1875
(Brandis, D. FRS and A. Smythies, BA; (5) Madurai Country Manual in Five Parts -
By J.H. Nelson (1868); (6) Madras District Gazetteers - Madura - Francis, W. - Fellow
of Fungs College (1905); (7) Manual of Administration of Madras Presidency -1885 -
3 Volumes; (8) Report for the select committee on Forestry, 1885 - Proceedings of
committee and Minutes of Evidence; (9) Annual Administration Report of Forest
Department - Madras Presidency, 1893; (10) Annual Administration Report of the
Forest Department - Madras Presidency - 12 months ending 30th June 1897 (1896-
97); (11) Tour information of some of the Forests of Madras Presidency - By G.S.
Hart, CLE., Inspector General of Forests, dated 31st January 1919; (12) Forests of
District (C. Wilson, 1916); (14) Ph.D Thesis of Tmt. D. Janaki - History of Forest
Administration in Tamil Nadu (1935-1967), 1996; (15) India Despatch No.75 of 1st
November 1862; (16) Manual of Forestry (1906) Schlich; (17) First Centenary of
Forest Administration of Madras State, Souvenir (Madras, April 1959); (18)
Statement of Forest condition in India - British Empire Forestry Conference,
London, 1920; (19) Report of the National Commission on Agriculture - Part IX
Forestry, New Delhi 1976; (20) The Madras Forest - Dyson W.G. 1912; (21) 100 Years
of Indian Forestry 1861-1961 Souvenir: (Dehra Dun, November 1961); (22) Forests
in India V.P. Agarwala, New Delhi - 1965; (23) Madras Information - G.O.T.N. -
Publication (Issues from October 1946 to 1968); (24) Forestry in British India. R.
Ribbentrop CLE Inspector General of Forests to Government of India - Calcutta
1900; (25) Forestry - Arthur Bernard Recknagel and Samuel Newton Spring, Cornell
University, New York, 1929.
Further Data referred to were obtained from:

(1) Working Plan and Gazetteers of Madurai District (1868 & 1905); (2) As per G.O. Ms. No.1416 Revenue Department dated 2-6-1951. The entire area was notified by the Collector under Section 26 of the Tamil Nadu Forest Act 1882 and published in the District Gazette dated 9-7-1951; (3) G.O. Ms. No. 1702 Food and Agriculture Department dated 16-5-61, appointing the Tahsildar (Forest Settlement Officer) ex-officio to be the Forest Settlement Officer to exercise the powers under clause (c) of the said Section 4 of the Act. Proclamation under Section 6 of the Management Forest Act, 1882 (published in 1963); (4) Jungle Conservancy Rules (Board of Revenue Standing Order No. 921); (5) Rules for Conservancy of Forests in Madras Presidency of April 1863; (6) Special Rules for Forest and Jungle Conservancy in several districts; (7) Madras Forest Act 1882, Sec. 4; (8) Sec. 4 notification as approved in G.O. Ms. No. 739, Forests and Fisheries Dept. dt. 28-7-77; (9) The notification was published in English (pages 477-478 of Tamil Nadu Government Gazette (Part - II - Section II) dated 31-8-77) and in Tamil in Madurai District Gazette dated 8-1-78; (10) G.O. Ms. No.3150, Agriculture Dept. dt. 4-12-71 to be handed over to the Revenue Department for eventual assignment; (11) G.O. Ms. No. 938, Forests & Fisheries dt. 8-8-84 ordering joint action of Forest, Police and Revenue should be identifying the encroachment; (12) Forest Development Plantation Journals and Records between 1953 to 1993; (13) Sirumalai Interface Forestry Division was formed on the 4th day of November 1991 as per the G.O. Ms. No. 569 Environment and Forests (FR VI) Dept. dated 17-9-91; (14) G.O. Ms. No. 351 Environment and Forests (FR VI) Dept. dated 21-10-93 and G.O. Ms. No. 216 Environment and Forests Dept. dt. 30-08-94; (15) To Board dated 28th October 1865, No.202 - pp 5; Giving Guidelines for Village Forest Council and Village Executive Committees.; (16) From do. dated 28th January 1856, No.302, Communicating order of Government dated the 14th January 1856 No.43 and the Board's Proceedings under dated the 13th December 1855, No.3285 - pp 5; (17) From Board (Circular) 14th April 1856, No.1114 - pp 8; (18) From Conservator of Forests, Madras, 21st December 1857, No.239 forwarding Lieutenant Beddome's Report dated 5th November 1857, No.11 - pp 10; (19) From Sub Collector 19th January 1858, No.14 - pp 14; (20) From Board 23rd January 1958, No.318 forwarding Ex.Min. Con 20th January 1858, No.83 - pp 17; (21) From Board 19th August 1858, No.3162, Communicating Ex. Min. Con. 5th August 1858, R.D. & the Conservator's Report to Government 1st May 1858, No.337 - pp 18; (22) From Conservator of Forests, 9th November 1859, No.843 forwarding copies of Reports on the Timbers of Madura

B. Use of available Remote Sensing Data /SOI Sheets to study the Forest Cover in Sirumalai Hills.

Surveying and mapping of extensive forest and other land area by conventional methods are time consuming requiring extensive manpower. Hence remote sensing data is used combined with limited ground surveying and field work for greater reliability within the limited span of time available.

Remote sensing technique derives information about objects on the surface of the earth without coming into contact with them as it involves making observations from a height such as from an aeroplane, a balloon or satellite.

Remote Sensing technology uses the visible, infrared and microwave regions of electromagnetic spectrum of sun's light energy. When the Sun's energy falls on the earth, it will either be reflected or absorbed or transmitted with respect to the nature of the object on which it hits. In this technology the reflected part of energy is used and recorded to obtain the data in different forms like imageries, digital, negative or positive etc.

The instruments that gathers this information are sensors such as Cameras and Scanners. The data thus 'sensed' are recorded on suitable materials like photographic film or magnetic tapes and transmitted to earth based stations. The information received is pre-processed after making suitable corrections for the orbiting motion of the earth, the scattering effects of the atmosphere and other possible variations. This data is obtainable from NRSA, Hyderabad.

Specialist Interpreters use the tone, texture, pattern, size and shape of entities in the sensed data to detect and identify objects. Satellite pictures are used by the interpreter to look at the context, the background - whether the lines represent lakes, railway tracks, roads, rivers or objects with closely similar lineaments. Seventy per
Remote sensing helps to understand ground realities much better. It enables repetitive coverage, allowing for the monitoring of time-dependent phenomena such as crop growth, change in cover, deforestation, etc. Remote sensing data is amenable to computer processing and use in a number of ways with the help of another technology that has gained importance over the last decade viz. geographic information systems (GIS). Also, Remote sensing coupled with GIS generates all possible dimensions of information for a desired objective.

Interpretation Methods

Interpretation of Remotely Sensed Data: Remote sensing data can be interpreted in two ways viz., visual and digital (for information extraction from them).

Visual Interpretation of Satellite Data: In visual interpretation, the interpretation elements, size, shape, shadow, tone, texture, pattern, location and association are used to differentiate two different adjacent objects. This is manual method of interpretation.

Interpretation Elements

(1) Size will vary with photographic scale. If scale is not evaluated correctly a house may be mis-interpreted as shopping complex or vice versa.
(2) Shape relates to the general form, configuration or outline of an object, like railways and highway road can be interpreted separately by their linear shape but with minimal or gentle curves in case of railway line rather the highway road.
(3) Pattern relates to the spatial arrangement of objects, like car parking in main roads or residential buildings or recreation places can be distinguished.
(4) Shadows the shape or outline of the shadow affords a profile / view of objects but it hinders the interpretation in the shadowed area.
(5) Tone is very important in identifying objects, and without this tonal difference the objects can not be differentiated from the adjacent object, like tar road absorbing all incident light energy so appearing black while adjacent sandy area or residential building reflecting the incident light energy appearing light grey or white.
(6) Texture is the frequency of tonal change in photographs - Paddy field will have smoother texture than the sugarcane field or coconut field because of the repetitivity of same object nearby.

(7) Site and location of objects in relation to other objects will be helpful, like black features adjacent to clouds will be differentiated from water body as shadow and because of shadow, clouds will be differentiated from snow cover (in hilly regions) or salt affected area (near command area or coastal muddy area).

Mapping Procedure followed for this study

1. Base map preparation using geographically referenced source (with same scale as that of satellite data) like Survey of India topomap.
2. Preliminary interpretation and delineation of objects into pre-defined number of classes with respect to the scale of data, date and time of acquisition of data and objectives of the map to be produced.
3. Identification of areas which have not been confirmed to any class of pre-defined classes and adjacent points which are identifiable both in image and in real like road crossing or railway line road crossing, edge of a big field or ground or industry.
4. Ground truth verification of the above marked doubtful areas
5. Finalisation of the primary interpreted map using the ground truth information.
6. Area calculation and conclusion from the map produced.

Methods of Mapping Using Plotters

1. Analogue procedure involving manual relative and absolute orientation of stereo models using stereoscopic plotting instruments is followed by measurement of model co-ordinates.
2. Analytical method in which co-ordinate measurement is done using numeric methods for mapping.
3. Semi analytical method in which manual relative orientation and analytical absolute orientation is done for the co-ordinate measurement.
4. Digital method uses the software for mapping by Digitised Aerial Photographs.
Digital Analysis of Remotely Sensed Data

Digital analysis involves the statistical analysis of the remotely sensed data which is available in digital mode i.e., the reflectance values converted in to digital numbers for easy analysis.

1. Image Rectification: The original image is converted in to a particular map projection or co-ordinate system so as to have a reference for ground control.
2. Image Enhancement: The modification of image to alter its impact on the viewer. This is to get the better image view than the raw image.
   i. Linear Stretch: Very few scenes have brightness range that utilise full sensitivity range of detectors. So the original range is stretched to full range of the detector to have a correct contrast image,
   ii. Density Slicing is the process of reducing the full range of grey levels in to minimum number classes for viewer perception,
   iii. Edge Enhancement is to emphasise grey scale variation to view distinct boundaries,
   iv. Filtering is the process by which the image matrix is multiplied with a square matrix to give objective oriented resulting image like geological features enhanced image or vegetative feature enhanced image or land water differentiated image.

Information extraction is done from the corrected image.

A. Image ratioing is the process of dividing digital numbers of one band by other band digital numbers of corresponding pixel position. This has been found useful in the identification of different types. Three ratio images can be given blue, green, and red colours to get a composite.

Normalised Difference Vegetation Index (NDVI) is the ratio of Near Infrared and Red band values i.e., $\text{NDVI} = \frac{\text{NIR}-\text{Red}}{\text{NIR} + \text{Red}}$

B. Image classification is the analysis of different spectral band signatures and assigning elements to different groups. Supervised classification is widely used rather than the Unsupervised classification.

a. Supervised classification uses known spectral reflectance data of different groups of certain training areas are identified on the imagery from which the
computer obtains classification parameters. Using this the full image is
classified in to different groups.

Different classifying techniques like parallel piped classifier, minimum distance to
mean and maximum likelihood classifier are used.

b. Unsupervised classification in which the image is classified without the
information of the scene by defining the classification boundaries based on
the statistical properties of the image.

Merits of Visual Interpretation over Digital Analysis

1. Visual Interpretation is cost effective than digital analysis, because digital
analysis is expensive demanding hardware and software).
2. There is no chance of mis-classification which may occur in digital analysis
due to the similarity in reflectance value of different objects, since manually
interpreted.

In this visual method we can identify and classify features into very few classes, say
10 to 15 and within each class normal human eye can differentiate upto 2 or 3 types.
Hence this method can safely be used for broad landuse/land cover classification
for small scale mapping purposes.

For detailed classification, digital analysis can be depended upon remotely sensed
data which are available in the forms Computer Compatible Tape, Cartridges and
small scenes in floppies and such digital analysis has been used for crop inventory,
crop classification, forest type classification and soil moisture studies.

Merits of Digital Analysis

1. Up to 3rd or 4th level classification can be done because of the computer
capability to discriminate full spectral grey levels of image.
2. Different enhancement and filtering techniques can applied to distinguish
specific features of interest.
3. Scale is not the factor for classification as in visual media
4. No chance of error in area calculation of classified image.

The present study area is mainly forest in Dindigul Mannar Thirumalai district of
Tamil Nadu and the forest Sirumalai lies between 10°05’ N to 10°15’ N Latitude and
77°53’ E to 78°10’ E Longitude. The forest is surrounded by some of the villages
and towns like Dindigul, Gandhigram, Vellodu, Saanarppatti, Mettuppatti, Valayappati, Anjikulippatti etc.

Materials Used

1. Survey of India (SOI) Toposheets of 1:50,000 scale
   - 58F/15, 58F/16, 58J/3 & 58J/4
2. IRS IB LISS II Dia-positive of 24/61 path/row dated 09.03.94
3. IRS IB LISS II Dia-positive of 24/61 path/row dated 22.01.90
4. IRS IB LISS II Digital data of 24/61 path/row dated 09.03.94

N.B. Attempts made to access data of 1985 and earlier period from NRSA, proved futile

An examination of the commission errors suggest that they vary from a minimum zero (clouds) to maximum of 25% as in the case of pastures. The need for an altitudinal mask while doing the classification is therefore felt strongly.

Methodology

The base map is prepared using SOI toposheets with the location of towns road and railway network along with reserve forest boundary. The visual interpretation equipment PROCOM was used to interpret the different forest density classes and surrounding landuse classes for 09.03.94 and 22.01.90 data.

False Colour Composites (FCCs) (Plate-3) of the imagery were visually interpreted in conjunction with SOI maps at 1:250,000 and 1:50,000 scale. Remote Sensed software was overlaid on SOI sheets and demarcation done and different distinctive colours given for different types / categories. Forest vegetation and other land cover features were delineated using image characteristics viz. tone, texture, pattern, location, etc. The area is characterised by a large diversity in floristic composition based on altitude. Hence the contours on the SOI maps were also used in addition to ground information to aid interpretation of forest types. (October data was found useful because of better discrimination of forest against grassland and other land covers).

The forest classes like Dense forest, Sparse forest, Degraded forest, Forest with Scrub and Open forest were delineated and verified during the ground truth verification. The scale and categorisation was done on the descending order of density. The vegetation reflects most of the infrared region of the sunlight which intern appears as red colour in the false colour composite of the remote sensing.
data. Forests are seen in various tones of reddish to brown and smooth to rough
texture depending upon the type and density of the forest cover. The different
shades of red like bright red, brownish red, pinkish red are useful in identifying the
vegetation and forest types. Dense forest is delineated with bright red and pinkish
red colour and smooth texture. Sparse forest is delineated with rough texture and
scattered red colour with yellow patches. Degraded and Scrub appears as brownish
yellow or bluish grey colour with tonal differences. Fallow land appears as pale
green/pale brown (Rlate-4 & 5).

The unreserved forest area in the outer skirt of the RF were mostly found with
plantation but with visual interpretation the plantation could not be distinguished
from dense forest. But most of this area is covered with plantation crops like
cashew, lime, silver oak, coffee, banana etc.

The digital data was also analysed using IURISI image analysis and GIS system
where the different classes of forest could be identified. The digital data of IRS LISS
II of 1994 was loaded into the IDRISI software and the false colour composite was
generated for hotter identification of training sites for the classification. Training
sites were given for the dense forest, sparse forest, degraded and scrub forest,
agricultural and fallow lands. Since the dense forest area has different shades of red
due to the different tree species 5 to 6 training sites were given for the dense forest
class and then they were accumulated to a single class. Then the image was
classified using all four bands of LISS II with maximum likelihood classifier of the
image analysis system.

After the preliminary analysis the classified image was verified with ground truth
information and corrections were carried out for the finalisation of the map.

A change monitoring study was also carried out for the Sirumalai forest to find
changes in land cover/vegetation cover during 1990-94 period and to understand
the factors responsible for these changes. From the observed changes in vegetation
density at two different times backed by ground and field verification, it is possible
to deduce the causes with some degree of reliability.
C Socio-Economic Field study in Villages to Analyse the causes of Deforestation and Evolution of Solution for Eco-friendly Management Approach

Forest may be viewed as a multifaceted asset capable of yielding a stream of benefits to present and future generations on an infinite time-scale. Loss of Forests is a cause of concern because of the possible impairment of ecosystem functions due to a breakdown of the ecological network at a crucial step and consequent reduction of ecosystem services available to man. This issue can be looked at from two distinct though related, standpoints - ecological and economic. The ecological approach would be to prioritise species or species-sets based on their (biological) conservation value and to consider strategies to protect the prioritised elements. The relevant studies are essentially of a nature-nature interaction kind with man, if accounted for, as a part of the ecological complex in question.

The economic approach would be to analyse the man-nature interface with the express objective of identifying the underlying economic causes of biodiversity loss (e.g. unsustainable extraction for short-term benefits or limits on options) and to devise incentives, to counter such tendencies. Clearly, integrated economic-ecologic approach would be a dovetail of nature-nature and man-nature interaction studies where the distinctive form of human interaction with nature will be explicitly recognised. In other words, the study would be sensitive to the unequal access of different human communities to biological resources and the differential impact of reduction ecosystem functions on various segments of society.

1. The present study will fall broadly under the category of man-nature interaction studies. Specifically, we shall look at interactions of the subsistence-dependence type where a community living physically close to a resource have traditionally relied on the exploitation of the resource to fulfil its subsistence requirements. The relationship of such communities with nature is necessarily of a more direct kind as compared with a corresponding urban community. By implication, the impact of loss or reduction of such a resource will be far greater on the former whose resource area is spatially restricted.

2. At the same time, absence of alternative employment opportunities coupled with imperfect links with the external market may result in unsustainable extraction of a resource as the market, as an institution, is generally incapable of allocating resources efficiently in the short run. In general, conservation
benefits *ewe* undervalued in the preference functions of the urban consumers as biological resources tend to be viewed as purely 'use' items than 'use-cum-existence resources.

3. In this study, broad components of a feasible economic strategy are looked into for biodiversity conservation, incorporating some of the incentives for the conservation strategy. At some level, sensitisation of the issues to the proximate need of communities in Sirumalai which are ecologically handicapped are needed; in a sense, forming a sub proletariat class who have limited access to information and whose survival needs are perpetually left out of conventional (ecological) discourse,

The field work involved surveys at the village level to gain a broad appreciation of the lifescape and peoplescape of the study site.

**Sampling Design and Size**

For the Socio-economic study a Stratified Random Sampling Design was employed. Stratification and selection of villages formed the first stage and selection of villagers within the villages formed the second stage.

The study sites differ widely with respect to ecological conditions and corresponding man-nature relations. An attempt to highlight the distinguishable common elements of ecological relationships as well as those which show marked variation amongst the study site has been done.

The field work involved surveys at the village level in 3 strata (viz.; (1) top level villages near forests, (2) villages in Sirumalai area plateau lying within forests and (3) plains villages lying scattered around the foot of Sirumalai Hills) to gain a broad appreciation of the lifescape and peoplescape of the study site.

In each stratum, villages in and around Sirumalai Forest sites were selected to represent different ecoclimatological zones of the study area. For collection of data and selection of villagers, stratification was done based on "user groups*1, as under:
The villages were selected to represent different ecozones which will manifest parameters relevant to this study. After an initial rapport building phase, a series of group discussions, individual interviews and landscape mapping exercises were conducted to realise the study objectives.

For selection of sample of 216 users, the population considered was 2354 in top level villages, 4330 in villages lying within forests and 3840 in plain villages lying scattered around the foot of Sirumalai Hills. So the sample size works out to 2% of the universe.

For the field study we included one or more members familiar with the study area preferably a tribal or a local low level functionary (Fire Watcher). To guide and focus the interview, a comprehensive questionnaire has been used (Appendix-/) which covered all the parameters and variables relevant to the socio-economic study. In each study site, we initially built up a good rapport. The team then conducted a grama sabha to explain the strategy, approach and purpose of this survey which most villagers approved. This was followed by a series of group discussions with various social strata. These were supplemented by individual interviews, field visits and mapping. At the final stage, another grama sabha was
called to brief the entire village about the outcomes of the study and desired follow-up.

For the analysis it is convenient to define a category 'biodiversity user group' in terms of the nature of use of (and corresponding relation with) biological resources by a group of individuals or a community. This category is more appropriate in our context than 'occupation' since an individual may use biological resources in more than one way and so, belong to more than one user group. The term 'user-group' hence, refers to a functional relationship. The nature of utilisation of and conservation stakes on biological resources show wide variation across user-groups. The major influencing factors may be identified as follows:

The stability of user groups over time depends largely on the availability of alternative employment opportunities of the secondary and tertiary type. With emergence of occupations like wage labour and other forms of unskilled or semi skilled work, dependence on traditional occupations like collection of medicinal plants goes down to user groups that tends to become more fluid with a quicker transition from primary resource users to more remunerative occupations often resulting in over use of the available resource.

Just like all villages in a region have different relationship with the forest resource, so do the various socio-economic groups in a village. An alternative strategy was employed to know that if the choices people make for conservation differ depending upon their occupation, culture etc. So people of each village/study site have been broadly classified into a few user groups. Each user group was identified with the help of distinctive socio-economic features, especially some characteristic relationship with forest resource and biodiversity which other groups lack. Thus, user groups such as big landlords, labourers, forest produce collectors, etc. emerged. This was followed by study of perceptions of these user groups, available in the village about forest resource biodiversity, its utilisation, ecological history and their management options. The views of each user group on the developmental aspirations in relation to biodiversity.

The focal questions are, whether people are interested in and affected by current development practices and activities? What alternatives do they suggest? What ways do they suggest to reconcile conservation and development? What systems of property rights, rewards/regulations would motivate people to conserve forest wealth and biodiversity? What modifications are necessary in current systems of governance, information and legislation?
Special attention was paid to seeking views of women and children, as well as reactions of stakeholders from outside like higher government officials, traders, migrants etc. All this revealed a variety of consensus and conflicts between different sections of the society. All this was used as inputs for formulating a conservation strategy and ecofriendly plan of management as conservation was considered as maintenance of biodiversity through appropriate management practices which involve a judicious mixture of protection, regulation and sustainable utilisation activities.

The observations and findings were then compiled into a comprehensive document.

Data on flora and fauna as recorded in the secondary data have been cross checked at the micro level by ground level on foot surveys and enquiries with local people. Also, for primary data, partially structured, pre-tested interview schedules were used at different levels of elevation in the forest area to assess the observed changes in the area, density of forest at varying elevation levels and the reported causes including forest clearing and formation of coffee estates, raising of elevation specific non-food commercial and food crops. This has been matched with official data.