Land A Finite Resource

CHAPTER 1 Land: A finite resource

Introduction

1. Land is a ubiquitous but limited resource. It is subject to competing pressures from urbanisation, infrastructure, increased food, feed, fibres and fuel production and the provision of key ecosystem services. But it is also a shrinking resource. The everincreasing population has resulted in a gradual decrease in per capita availability of land. Further, due to the rapid industrialization and population growth, land resources are under pressure from physical, human and global causes such as soil erosion, desertification, pollution, food shortage, land conflict, water shortage and climate change.

2. Land-use change has broad lines of impact, influencing economic growth, quality of life, management of environmental resources and national food supply. Given the finite supply of land resources, it is important that this land-use change is not indiscriminate. It is imperative that diversification and urbanization are planned in a manner that while responding to the market needs, it keeps sustainability is at the core of these decisions. The challenge here is that given the variedness of its characteristics, different types of land and locations are not equally suitable for different purposes. Hence, the need arises for appropriate land use planning – including land monitoring and management – for sustainable development.

3. Information on the status of land and monitoring the changes therein will also help in addressing many of the SDGs like SDG 2 - 'Zero Hunger', SDG 11 - 'Sustainable cities and Communities' and SDG 15 - 'Life on land'. Four of the targets - SDG 2.4, 11.3, 15.1 and 15.3 - explicitly refer to quality and utilization of land in a sustainable manner. The role of the policy makers is to keep a tab on the health of this precious resource so as to ensure unhindered basic ecological services, socio-economic and political security and resilience to climate change for the generations to come.

4. In this direction, this chapter discusses three main datasets on land that are available in India – the Land Use Land Cover, land degraded by various natural and anthropogenic processes and the wastelands in the country.

Land Use Land Cover (LULC)

5. The two main characteristics on the basis of which land is classified are land use (LU) and land cover (LC). Land Cover can be defined as observed physical features on the Earth's Surface, which transforms to Land Use when a socio-economic function is added to it. Given the fact that increasing anthropogenic activities around the biosphere are causing large-scale alterations of the Earth's land surface, land-use and land-cover (LULC) change is an important indicator for monitoring environmental changes and a vital input for informed decision making in the context of land management.

6. In India, land-use and land-cover (LULC) statistics are maintained by National Remote Sensing Centre (NRSC), Department of Space (DOS) through a component on National Land Use/ Land Cover (LULC) mapping of the Natural Resources Census (NRC) Project of National Natural Resources Repository (NRR) Program. LULC datasets are made available on a periodic basis by NRSC on a 1:50,000 scale, where the LULC data is grouped as per the classes described in **Table 1**.

S1.	Level-I	Level-II
I.	Built-up	Urban
		Rural
		Mining
II.	Agriculture	Crop land
		Plantation
		Fallow
		Current Shifting Cultivation
III.	Forest	Evergreen /Semi-evergreen
		Deciduous
		Forest Plantation
		Scrub Forest
		Swamp / Mangroves
IV.	Grass/ Grazing	Grass/ Grazing
V.	Barren / unculturable/	Salt Affected Land
	Wasteland	Gullied / Ravinous Land
		Scrub land
		Sandy area
		Barren rocky

Table 1: Grouping of Land Use and Land Cover (LULC) Classes

S1.	Level-I	Level-II
		Rann
VI.	Wetlands / Water Bodies	Inland Wetland
		Coastal Wetland
		River / Stream / Canals
		Water bodies
VII.	Snow and Glacier	Snow

7. LULC datasets are also made available on a 1:250000 scale by NRSC on an annual basis at <u>https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php.</u>

Land Accounts in SEEA-CF

8. Land is an environmental asset that outlines the space in which all the natural processes and human/economic activities are occurring. Land accounting inputs are of particular importance for starting environment accounts, because they provide the means to initiate the following tasks:

- Apply land cover types as proxy for ecosystem units (or assets);
- Apply land use to delimit areas where ecosystem services originate; and
- Help harmonize various inputs from scientific data to assess condition and services like water run-off, habitats and carbon storage.

9. Land accounts register both the state of land cover and use at a certain time, which can be termed as land stocks and include the extent (area), type (which can be further related to indicators on condition) other properties (e.g. ownership); and also the changes between at least two steps in time (or flows). It may be useful to distinguish in these accounts the 'naturally-driven' changes and those driven by human actions (anthropic).

10. The SEEA-Central Framework provides guidance on both land cover and land use accounts preparation separately, but the existing practical experience mostly shows evidence on combined applications on only land cover. Land use remains a more challenging subject to map, in part because of the overlapping nature of land use activities, and difficulties in summarizing dominant ones. A one-to-one concordance of LULC adopted in the India with LULC, SEEA-CF is given in **Table 2** below.

LULC Classes in India	LULC under SEEA-CF	
Urban	Artificial surface (including urban and	
Rural	associated areas)	
Mining		
Crop land	Herbaceous crops	
Fallow	Multiple or layered crops	
Current Shifting Cultivation		
Plantation	Woody crops	
Evergreen /Semi-evergreen	Tree-covered areas	
Deciduous		
Forest Plantation		
Scrub Forest	Shrub-covered areas	
Swamp / Mangroves	Mangroves	
Grass / Grazing	Grass land	
Salt Affected Land	Sparsely natural vegetated areas (partially)	
Gullied / Ravinous Land	Terrestrial barren land	
Scrub land		
Sandy area		
Barren rocky		
Rann		
Inland Wetlands	Inland water bodies	
River / Stream / Canals		
Water bodies		
Coastal Wetlands	Coastal water bodies and intertidal areas	
Snow	Permanent snow and Glacier	

Table 2: Comparison of Land Cover Classes under SEEA- CF vs. Classes in India

Asset Account for Land Cover

11. The framework suggested in the SEEA CF for preparation of asset accounts for land cover requires segregated information on natural and managed activities leading to the changes in land cover. As these are not readily available, the land cover accounts are presented in this publication at a more-aggregate level.

12. NRSC, under its Natural Resources Census (NRC) Project, has produced the LULC datasets for the years 2005-06, 2011-12 and 2015-16 and these have been

disseminated through the Bhuvan website¹. Discussions on 2005-06 and 2011-12 have been presented in EnviStats India 2018 (Supplement on Environment Accounts)². These LULC datasets are made available by NRSC on a 1:50,000 scale, where the LULC data is grouped as per the classes described in **Table 1**. The all-India change matrix of LULC from 2011-12 to 2015-16, as provided by NRSC, is given in **Statement 1.1** at the end of the chapter. Based on this change matrix, the asset account for land-use land-cover is given in **Table 3**. The state-wise asset account for land-use land-cover is given in the **Annexure-1.1** and the corresponding change matrix is given in **Annexure 1.2**.

				,	1 /	
		INDIA				
Level-1	Level-2	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)	
	Crop land	15,53,007	41,056	90,107	15,03,956	
	Current Shifting Cultivation	3,743	2,633	2,353	4,023	
Agriculture	Fallow	1,81,469	79,956	33,247	2,28,179	
	Plantation	83,514	4,346	2,742	85,118	
	Sub Total 1	18,21,732	1,27,991	1,28,448	18,21,276	
	Barren Rocky	1,73,986	3,540	72,371	1,05,154	
	Gullied / Ravinous Land	7,511	2,898	468	9,941	
Barren/	Rann	18,822	0	132	18,690	
Unculturable/ Wastelands	Salt Affected Land	9,610	372	228	9,754	
	Sandy Area	30,644	3,471	680	33,436	
	Scrub Land	1,84,144	12,602	9,862	1,86,885	
	Sub Total 2	4,24,717	22,883	83,740	3,63,860	
	Mining	6,024	907	310	6,620	
	Rural	74,653	658	233	75,079	
Builtup	Urban	38,321	2,201	372	40,150	
	Sub Total 3	1,18,998	3,766	916	1,21,848	
Forest	Deciduous	4,44,433	3,753	11,300	4,36,886	

Table 3: Asset Account for Land Use Land Cover (LULC) in India

(Area in sq.km)

¹ <u>https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php</u>

² http://www.mospi.gov.in/publication/envistats-india-2018-supplement-environmental-accounts-0

			IN	DIA	
Level-1	Level-2	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
	Evergreen/ Semi evergreen	1,56,105	1,134	4,194	1,53,045
	Forest Plantation	23,895	330	871	23,355
	Scrub Forest	96,406	11,466	8,252	99,620
	Swamp / Mangroves	4,704	66	47	4,723
	Sub Total 4	7,25,543	16,749	24,663	7,17,629
Grass /	Grass / Grazing	25,397	1,049	2,894	23,551
Grazing	Sub Total 5	25,397	1,049	2,894	23,551
Snow and	Snow and Glacier	32,581	70,525	1,782	1,01,325
Glacier	Sub Total 6	32,581	70,525	1,782	1,01,325
	Inland Wetland	8,175	458	1,027	7,606
	Coastal Wetland	10,719	189	121	10,787
Wet lands/ Water bodies	River/Stream/ Canals	61,032	2,130	2,333	60,829
	Water bodies	58,367	1,478	1,293	58,552
	Sub Total 7	1,38,294	4,254	4,775	1,37,774
Grai	Grand Total		2,47,218	2,47,218	32,87,263

Note: Calculations made on the basis of the change matrices given by NRSC¹.

Land Degradation (LD)

13. Land degradation is the loss of biodiversity and productivity that arises from the physical, chemical and biological degradation of the land. It affects the entire natural environment, resulting in losses of ecosystem services that have far reaching effects on human welfare and the global economy. It also has a close connection with other major global issues, particularly climate change and biodiversity.

14. Degraded land is a threat multiplier for communities, as it reduces people's ability to use their land and limits their access to resources. The main anthropogenic factors contributing to land degradation include deforestation and land clearing for economic use and to cope with increasing urbanization. In some instances, the economic demand for agricultural land has led not only to land clearing but also over-cultivation, overgrazing, insufficient crop rotations and the overuse of agrochemicals. These practices are focused on short-term production and profitability in order to meet the demand of growing populations. There is an urgent need to stop and reverse the process of land degradation for ensuring food, water and environment security as well as to improve the living conditions of population residing in such areas.

15. Carbon sequestration is an important function of soil, as it can retain three times as much carbon as the atmosphere if soil quality can be managed. Practices that degrade land, however, contribute one-third of anthropogenic greenhouse gases, and conversely, reversing land degradation can help to slow the rate of climate change.

Land Degradation Statistics in India

16. The spatial distribution of various types of land degradation is important for planning reclamation activities and increasing the agricultural production of the country. National level land degradation mapping is taken up by ISRO along with partner institutions, under Natural Resources Census (NRC) mission of DOS/ISRO, towards generating information on land degradation at 1:50,000 scale.

Classification System of Land Degradation

17. Two cycles of land degradation mapping at 1:50,000 scale, for the timeframe 2005-06 and 2015-16, have been accomplished by NRSC. Land Degradation (LD) classification scheme of 2nd cycle was slightly modified based on the experiences gained from 1st cycle of Land Degradation mapping. The major classification scheme was the same as that used in the 1st cycle, but the land use and landform attributes in the classification scheme of 1st cycle were dropped in 2nd cycle. The classification system broadly consists of eight land degradation processes and 36 land degradation classes. The land degradation classification scheme of 2nd cycle, the results of which were published in **Status of Land Degradation in India 2015-16³**, is given in the **Table 4** below.

LD Process	LD Code	LD Class	
	A1	Sheet – Slight	
	A2	Sheet – Moderate	
	A3	Sheet - Severe	
Water Erosion	A4	Rills	
	A5	Gullies	
	A6	Ravines - Shallow	
	A7	Ravines - Moderately deep to deep	

³ Status of Land Degradation in India-2015-16, National Remote Sensing Centre

LD Process	LD Code	LD Class			
	B1	Sheet - Slight			
	B2	Sheet - Moderate			
Mind English	B3	Sheet - Severe			
Wind Erosion	B4	Stabilized dunes			
	B5	Partially-stabilized dunes			
	B6	Un-stabilized dunes			
	C1	Surface ponding -Seasonal			
Water Logging	C2	Surface ponding - Permanent			
	C3	Sub - surface Waterlogging			
	D1	Saline - Slight			
	D2	Saline - Moderate			
	D3	Saline – Severe			
	D4	Sodic- Slight			
Salinisation/	D5	Sodic - Moderate			
Alkalization	D6	Sodic - Severe			
	D7	Saline Sodic - Slight			
	D8	Saline Sodic - Moderate			
	D9	Saline Sodic - Severe			
	D10	Rann			
Acidification	E1	Acidity - Moderate			
Acidification	E2	Acidity - Severe			
Glacial	F1	Frost heaving			
Glacial	F2	Frost shattering			
Anthropogenic	G1	Industrial-effluent affected areas			
Anthronoconia	G2	Mining & dump areas			
Anthropogenic	G3	Brick kiln areas			
	H1	Mass movement / Mass wastage			
Others	H2	Barren rocky/ Stony waste			
	H3	Miscellaneous-Riverine sands / Sea ingress areas			
Normal	N	Normal			

Land Degradation (LD) Account

18. Based on the change matrices of the States for the year 2005-06 and 2015-16 as given in the NRSC report on land degradation cited above, the Opening Stock, Addition to Stock, Reduction in Stock and Closing Stock have been obtained for all the States. The

Land Degradation account for all the States is given at **Annexure 1.3.** However, the Land Degradation account for the country is given in **Table 5** below.

01	Category	INDIA				
S1. No.		Opening Stock (2005-06)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)	
1	A1	90,21,278	4,73,271	2,50,540	92,44,009	
2	A2	240,97,842	6,78,168	7,74,272	240,01,738	
3	A3	142,08,316	4,07,557	5,51,819	140,64,054	
4	A4	11,46,654	509	1,261	11,45,902	
5	A5	18,21,440	367	3412	18,18,395	
6	A6	4,19,647	0	207	4,19,440	
7	A7	3,02,764	0	0	3,02,764	
8	B1	55,55,372	1,098	482	55,55,988	
9	B2	10,69,056	14,866	14,696	10,69,226	
10	B3	10,50,201	28	3,,898	10,46,331	
11	B4	21,62,867	4,39,199	11469	25,90,597	
12	B5	41,30,564	1055	5,21,332	36,10,287	
13	B6	4,31,766	166	24,615	4,07,317	
14	C1	16,00,407	73,581	1,02,305	15,71,683	
15	C2	1,20,917	15,971	19,369	1,17,519	
16	C3	1,29,077	7794	4,278	1,32,593	
17	D1	14,36,617	31,457	41,656	14,26,418	
18	D2	17,34,701	0	0	17,34,701	
19	D3	9,88,600	22,059	52,801	9,57,858	
20	D4	2,93,163	15,125	23,992	2,84,296	
21	D5	6,63,530	2,531	4,299	6,61,762	
22	D6	3,52,963	1,170	4,058	3,50,075	
23	D7	73,150	1,092	653	73,589	
24	D8	4,07,522	5,129	2,309	4,10,342	
25	D9	3,46,505	4,887	4,255	3,47,137	
26	D10	2,22,537	722	4,829	2,18,430	
27	E1	28,36,944	6,776	5,341	28,38,379	
28	E2	2,08,581	1,350	6,832	2,03,099	
29	F1	3,25,129	0	0	3,25,129	
30	F2	25,58,729	0	0	25,58,729	
31	G1	38,951	12,188	14	51,125	

Table 5: Land Degradation (LD) Account

(Area in ha)

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C1		INDIA				
S1. No.	Category	Opening Stock (2005-06)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)	
32	G2	3,86,374	1,32,649	985	5,18,038	
33	G3	63,367	30,160	7,900	85,627	
34	H1	4,69,855	5,514	158	4,75,211	
35	H2	101,40,204	0	25,697	10,11,4507	
36	H3	4,82,606	9,700	17,951	4,74,355	
37	Ν	4,41,735	5,32,680	4,41,735	5,32,680	
	Total	917,39,931	29,28,819	29,29,420	917,39,330	
Land	Degradation Total	912,98,196	23,96,139	24,87,685	912,06,650	

Note: Calculations made on the basis of the change matrices given by NRSC³.

Wastelands

19. Wastelands are degraded land which can be brought under vegetative cover, with reasonable effort, but which are currently under-utilized and deteriorating for lack of appropriate water and soil management or on account of natural causes. Wastelands include degraded forests, overgrazed pastures, drought-struck pastures, eroded valleys, hilly slopes, waterlogged marshy lands, barren land, etc. Increasing population is giving rise to a demand for land based products/services which include agricultural as well as non-agricultural purposes all over the world. In India, this demand for land has led to over-utilization of land resources regardless of their potential and limitations, resulting in the creation of vast stretches of wastelands. It has become imperative to identify lands suitable to create infrastructure, improve agriculture production, develop industrial zones etc. Thus, there is a persistent need to identify and reclaim those wastelands that have the potential for recuperation.

Wastelands Statistics in India

20. India contains more than 17% of the world population, while its land is only 2% of the total geographical area of the world. Naturally, the pressure on the land is beyond its carrying capacity in several regions of the country. Therefore, many productive lands are suffering various degrees of degradation and are turning into wastelands. As of 2015-16, approximately 55.76 million hectares is lying as wasteland in India, which is a significant 16.96% share of the geographical area of the country.

Classification System of Wastelands

21. The Department of Land Resources is the nodal agency in land resources management for striving to realize the previously stated objective same through various initiatives. Geospatial data generation of wastelands is one such enterprising step undertaken by the National Remote Sensing Centre (NRSC) at the behest of D/o Land Resources, primarily to showcase their spatial distribution and changes across the country. In this series of geospatial datasets on wastelands, the **Wastelands Atlas of India - 2019**⁴ has been compiled using remote sensing satellite data at a 1: 50,000 scale by NRSC.

22. In order to facilitate comparison between the two temporal wastelands vector datasets with respect to different classes and their spatial statistics and to identify the type of change, the number of wastelands classes in 2015-16 was kept the same by NRSC as it was in 2008-09. Thus, the number of wastelands classes during both the mapping cycles remained 23. Nine non-wastelands classes have been shortlisted as the probable cases of change from wastelands to these classes for facilitating change analysis. The description of individual classes is given in the **Table 6** below.

Type of land	Wasteland Code
Gullied and/or ravinous land (Medium)	1
Gullied and/or ravinous land (Deep)	2
Land with Dense Scrub	3
Land with Open Scrub	4
Waterlogged and Marshy land (Permanent)	5
Waterlogged and Marshy land (Seasonal)	6
Land affected by salinity/alkalinity (Medium)	7
Land affected by salinity/alkalinity (Strong)	8
Shifting Cultivation-Current Jhum	9
Shifting Cultivation-Abandoned Jhum	10
Under - utilised/degraded forest (Scrub domain)	11
Under - utilised/degraded forest (Agriculture)	12
Degraded pastures/grazing land	13
Degraded land under plantation crop	14
Sands Riverine	15

Table 6: Wastelands Classification System⁴

⁴ Wastelands Atlas of India-2019, National Remote Sensing Centre

Type of land	Wasteland Code
Sands Coastal	16
Sands-Desertic	17
Sands-Semi Stab-Stab>40m	18
Sands-Semi Stab-Stab 15-40m	19
Mining Wastelands	20
Industrial Wastelands	21
Barren Rocky/Stony waste	22
Snow covered/Glacial area	23
Non-Wasteland categories	
Built up	24
Industrial Area	25
Cropland	26
Fallow Land	27
Plantation	28
Forest-Dense/Open	29
Forest Plantation	30
Grasslands	31
Waterbodies	32

Wastelands Account

23. Based on the *change matrices* of the States/UTs for the year 2008-09 and 2015-16 as given in the Wasteland Atlas of India, 2019⁴, the Opening Stock, Addition to Stock, Reduction in Stock and Closing Stock have been obtained for all the respective States/UTs. The Wastelands account for all the States/UTs are given at **Annexure 1.4**. The Wastelands account at the national level is given in **Table 7** below.

Table 7: Wastelands Account for India

(Area in sq.km)

	INDIA						
WL Categories	Opening Stock (2008-09)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)			
1	6,586	97	199	6,484			
2	3,117	19	28	3,109			
3	80,646	4,343	11,017	73,972			
4	97,320	9,400	7,118	99,602			

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	INDIA						
WL Categories	Opening Stock (2008-09)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)			
5	1,785	116	274	1,627			
6	6,265	391	1,457	5,199			
7	5,169	142	587	4,723			
8	1,634	68	116	1,586			
9	4,397	2,506	3,032	3,871			
10	4,051	2,749	2,225	4,575			
11	86,954	1,091	1,634	86,411			
12	20,821	1,129	260	21,691			
13	6,867	4	421	6,450			
14	252	15	18	249			
15	3,165	105	149	3,121			
16	710	28	66	671			
17	8,324	583	715	8,192			
18	9,488	0	142	9,345			
19	13,045	11	1,255	11,801			
20	1,819	453	16	2,256			
21	205	114	1	317			
22	92,166	6,629	4,311	94,484			
23	1,11,287	4,401	7,760	1,07,928			
999	6,131	14,536	6,131	14,536			
Grand Total	5,72,202	48,932	48,932	5,72,202			
Total Wasteland	5,66,070	34,396	42,801	5,57,666			

Note: Calculations made on the basis of the change matrices given in the Atlas⁴.

Conclusion

24. Given the finiteness of land, an approach to sustainable land management is the need of the times, which harmonizes the complementary goals of providing environmental, economic, and social opportunities for the benefit of present and future generations, while maintaining and enhancing the quality of the land (soil, water and air) resource. In other words, the challenge is to ensure that the changing human needs (agriculture, forestry, conservation) are met, while ensuring long-term socioeconomic and ecological functions of the land.

25. Land management decisions are pivotal to ensure a sustainable growth in the economy. The concept of spatial planning has evolved which looks at the entire region in a holistic way, be it for regulating the built-up area or infrastructure development or managing eco-sensitive areas like river basins, watershed areas, wetlands, flood-prone areas, wildlife areas, mining areas, coastal areas, peri-urban areas, and areas having tourism potential. Especially in the face of climate change and variability, the various indicators of human footprint on land, like the use of land and its condition need to be assessed on a regular basis for scientific and effective land use planning, management and ecological restoration. To facilitate this, NSO India, in collaboration with all the other relevant agencies and using the available national data sources, envisages to make available to users, regularly updated information on land for the benefit of all the stakeholders.

Statement 1.1: Change matrix of Land Use - Land Cover (LULC) from 2011-12 to 2015-16

(Area in sq.km.)

LULC_ CLASSES		ALL INDIA							
		2015-16							
		1: Agriculture	2: Barren/ Unculturable/ Wastelands	3: Builtup	4: Forest	5: Grass / Grazing	6: Snow and Glacier	7: Wetlands / Water bodies	Grand Total
	1: Agriculture	1809033	5103	2648	2299	94	8	2547	1821732
2011-12	2: Barren/ Unculturable/ Wastelands	4237	348460	589	2285	61	68471	614	424717
	3: Builtup	238	442	118239	48	2	0	29	118998
	4: Forest	5085	6838	205	712342	207	637	230	725543
201	5: Grass / Grazing	147	408	118	368	22502	1333	521	25397
	6: Snow and Glacier	0	1643	0	131	7	30799	1	32581
	7: Wetlands / Water bodies	2536	966	49	155	679	77	133833	138294
	Grand Total	1821276	363860	121848	717629	23551	101325	137774	3287263

Source: National Remote Sensing Centre Note: Totals may not match due to rounding off.