Economic Costs of Land Degradation in India

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Date: 1st August 2019

Overarching objectives

- Assess scale of land degradation in the country with the economic impacts.
- Assess the quantum of investment required for undertaking preventive and restorative measures which can help achieve the aspirational goal of land degradation neutral India by 2030
- Six microeconomic case studies from across India

Defining the issue

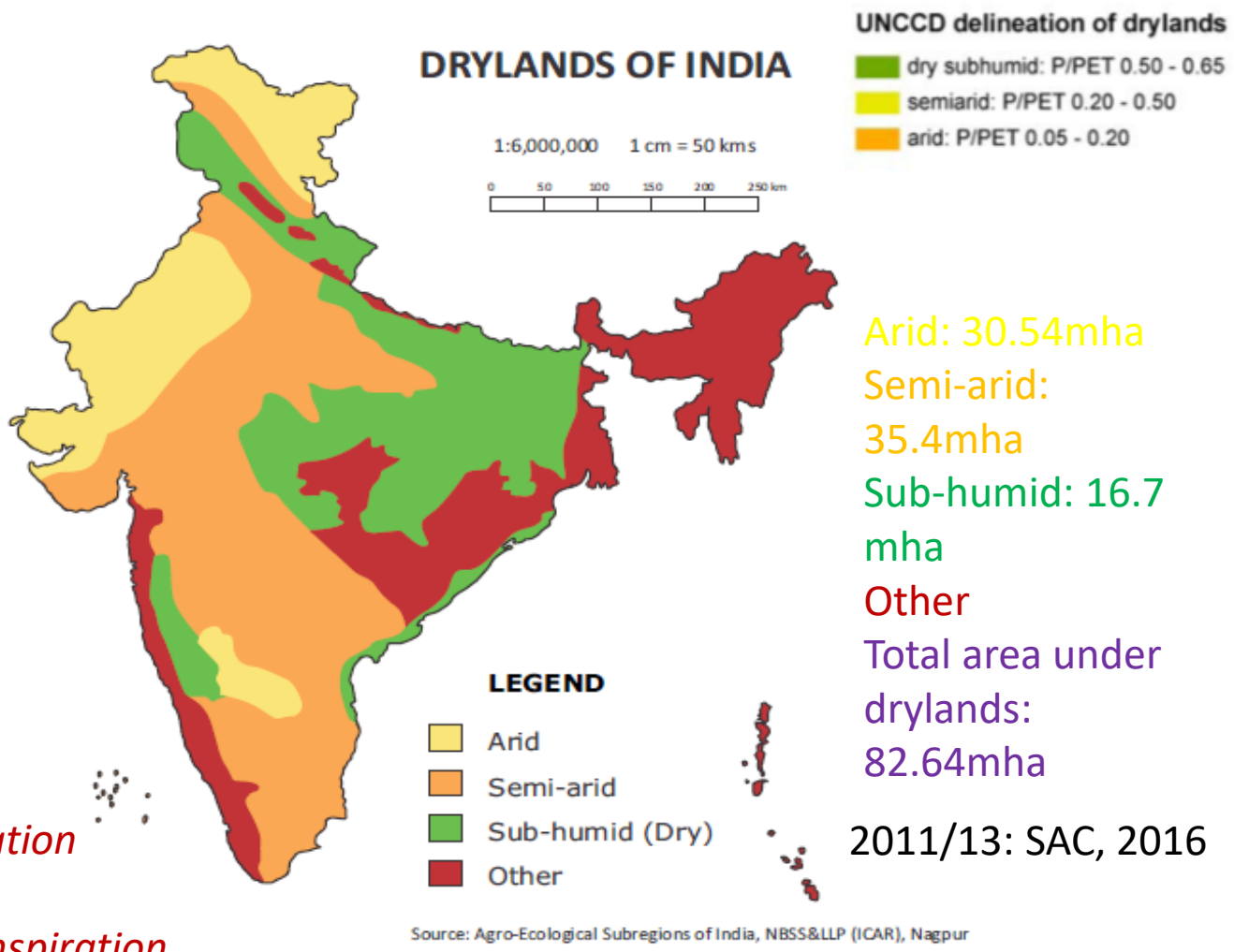
Land: The terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system(UNCCD, 1996, Part1, Article 1e).

Land Degradation: Reduction or loss of biological or economic productivity and complexity of rain-fed cropland, irrigated cropland or range, pasture, forests, & woodlands resulting from land use or from a process or combination of processes arising from human activities & habitation patterns such as

- Soil erosion caused by water and/or wind
- Deterioration of physical, chemical, biological or economic properties of soil
- Long-term loss of natural vegetation

Desertification: Land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities (UNCCD)

The Drylands of India



Arid: 30.54mha
Semi-arid: 35.4mha
Sub-humid: 16.7 mha
Other
Total area under drylands: 82.64mha

2011/13: SAC, 2016

Aridity index=P/PET

P=Mean annual precipitation

PET= Potential Evapotranspiration

Land Degradation Status of India

Process of LD/Desertification	Area (mha)	% of GA
Water and Wind Erosion	94.87	28.86
Acid Soil	17.93	5.45
Alkali/Sodic soil	3.7	1.13
Saline Soil	2.73	0.83
Water logged Areas	0.91	0.28
Mining/Industrial	0.26	0.08
Total Degraded Area	120.4	36.63

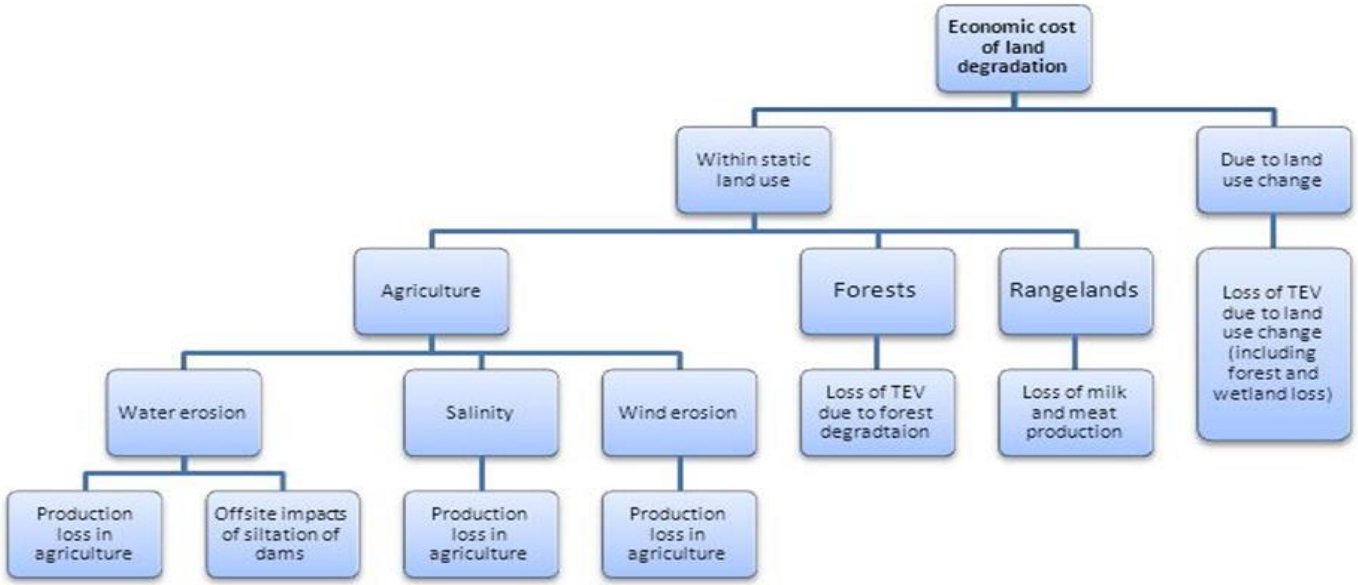
ICAR, 2010

Process of Desertification/land degradation	**2011/13**		**2003/05**		**Change (in mha) between 03/05 and 11/13**
	Area (mha)	Area (%)	Area (mha)	Area (%)	
Vegetation Degradation	29.3	8.91	28.28	8.6	1.02
Water Erosion	36.1	10.98	35.61	10.83	0.49
Wind Erosion	18.23	5.55	18.35	5.58	-0.12
Salinity	3.67	1.12	4.01	1.22	-0.34
Water Logging	0.65	0.2	0.6	0.18	0.05
Frost Shattering	3.34	1.02	3.11	0.95	0.23
Mass Movement	0.93	0.28	0.84	0.26	0.09
Manmade	0.41	0.12	0.37	0.11	0.04
Barren/ Rocky	1.89	0.57	1.88	0.57	0.01
Settlement	1.88	0.57	1.48	0.45	0.4
Total Area under Desertification	**96.4**	**29.32**	**94.53**	**28.76**	**1872523**
No Apparent degradation	226.73	68.97	228.68	69.57	-1954372
Total Geographical Area (mha)	328.72				

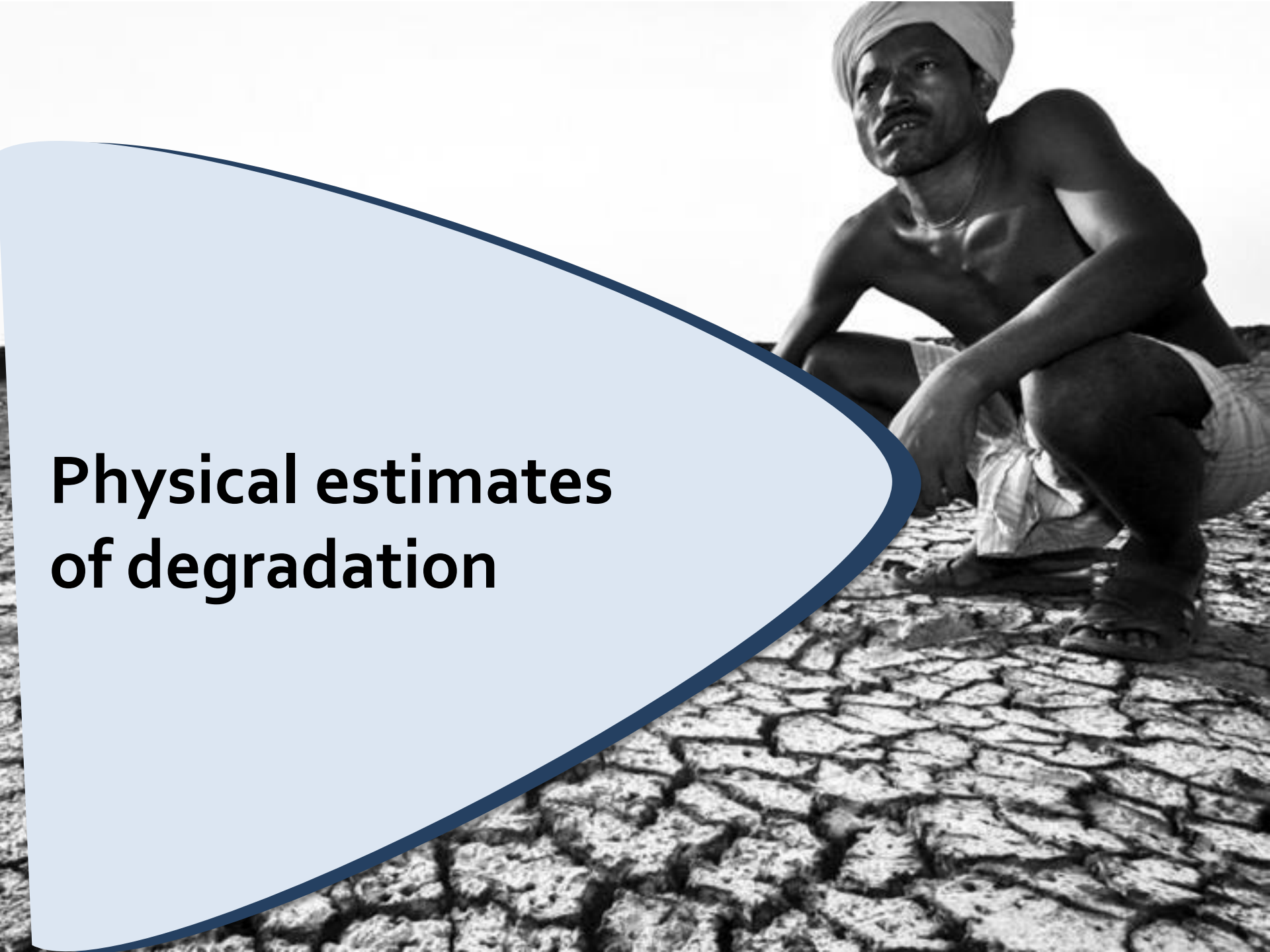
SAC, 2016

Macro-study approach

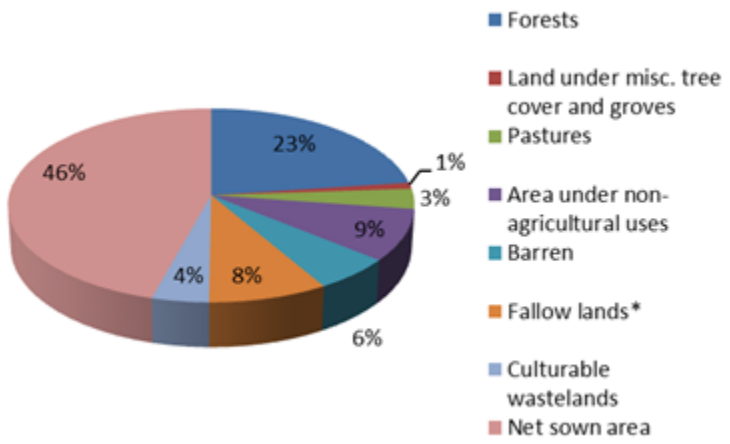
- 2 aspects of LD
  - Cost of degradation on a given land use (forests, agriculture, rangelands)-Static
  - Cost when land moves from a more to a less productive category-change within official 9 category land use & wetlands



Physical estimates of degradation

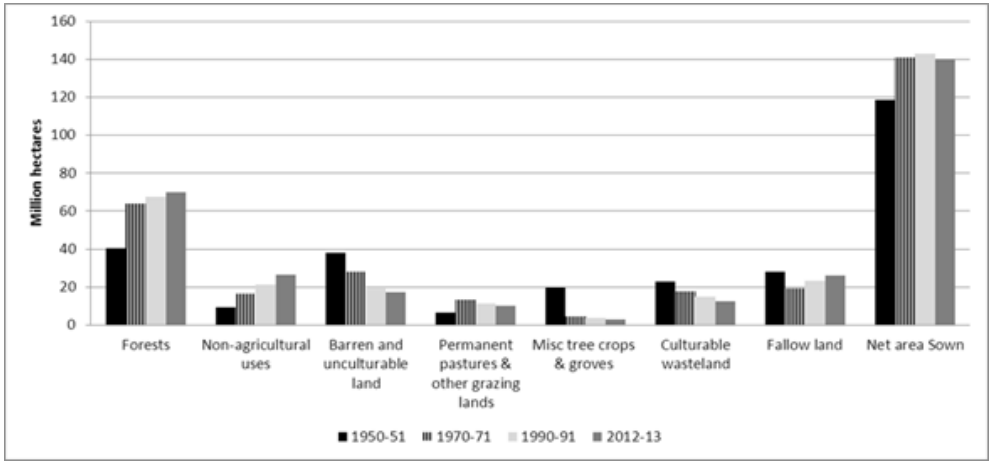


Land use change



% under various land uses in 2012/2013

Source: Ministry of Agriculture and Farmers Welfare



Land use change 1950/51- 2012/13

- Increase in area under non-agricultural use: 9mha in 1950/51 to 26 m ha in 2012/13. Highest growth rate in land use at all India level
- Increase in permanent fallow lands: 19mha in 70/71 to 26mha in 2012/13 (degradation from waterlogging and salinity or irrigation absence)
- Decrease in area under barren & unculturable lands, tree cover and culturable wastelands- 28% of land use in 1950/51-11% in 2012/13.

Forest and Tree Cover

Forest and tree cover: 80.2 million hectare-24.39% of the total geographical area (FSI, 2017). Forest cover : 70.83 mha-21.54% of India's GA

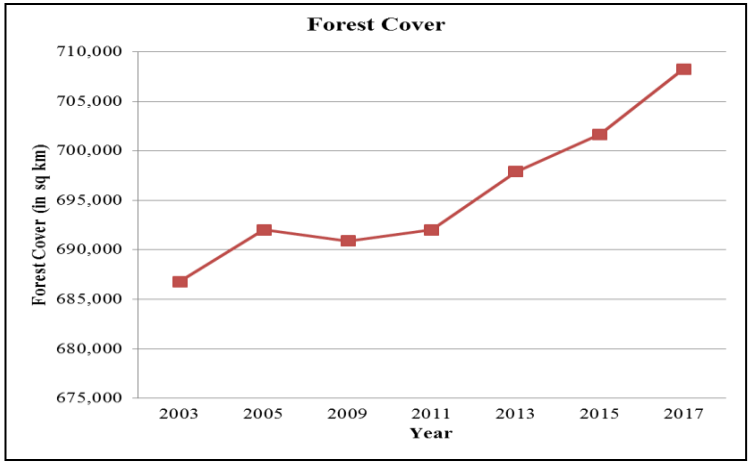
Open & Scrub= 34.78 mha (10.8% of GA or approx 49% of India's forest cover)

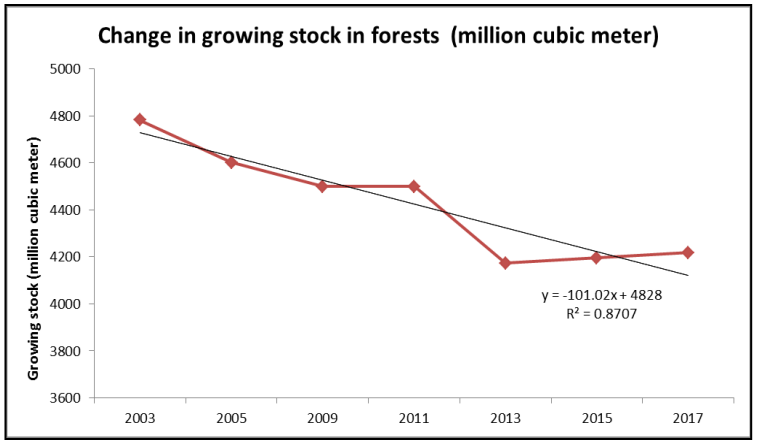
VDF= 9.82 mha; 2.99% of GA

MDF= (30.83 m ha; 9.38 % of GA)

Vegetal degradation=29.3 mha; 8.91% of GA –(SAC 2016)

Vegetation degradation is observed mainly as deforestation / forest-blanks / shifting cultivation and degradation in grazing / grassland as well as in scrubland.





Source: State of Forest Reports, FSI (2003-2017)

Forest densities (FSI, 2003)

Very Dense Forest >70%

Moderately Dense Forest (40-70%)

Open Forest (10-40%)

Scrub forests (degraded forests with canopy cover <10%). (FSI, 2015).

Grasslands

- Variable estimates of area under grasslands (MoA-10.5m ha in 2001- PC-38mha 1997)
- Largely guestimates (PC, 2011)
- 50-60% livestock (>500 million) supported by grasslands
- Livestock-8.5-9% of GDP (Planning commission, 2006)
- Rampant conversion of grasslands
- 3mha ha decrease since 2001-2003; 30% since independence
- Decline from 14 mha in 1960/71 to 10 mha in 2012/13

Wetlands

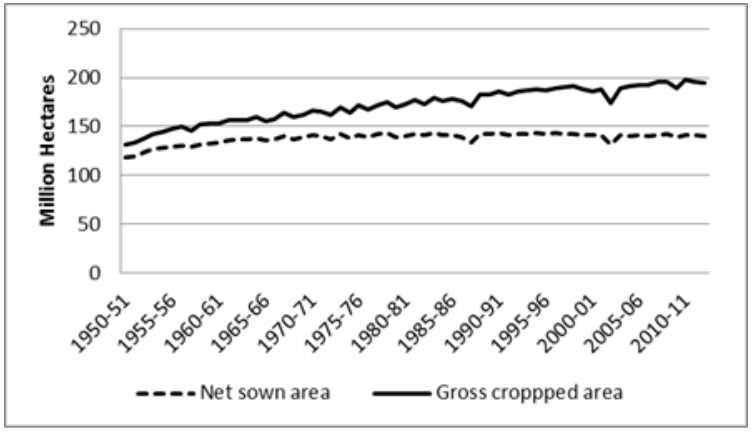
- Variable estimates of wetland areas
- Inland wetlands
  - 3.6 mha (SAC, 1998)
  - 7 m ha (SACON, 2004)
  - 10.56 m ha SAC (2011)
  - ISRO (2016)
- Again rapid draining & conversion

87% of wetlands lost globally in the last 300 years; 54% since 1900

Type of Wetlands	2005-06	2011-12	Change (Value)	% Change
Inland Wetlands (sq. km)	9935.08	7913.62	-2021.46	-20.35%
Coastal Wetlands (sq. km)	10639.57	15048.75	4409.18	41.44%
River/ Stream/ Canals Wetlands (sq. km)	60228.19	59096.89	-1131.3	-1.88%
Reservoir/ Lakes/ Ponds Wetlands (sq. km)	48135.68	53948.37	5812.69	12.08%
Total wetland area (sq. km)	128938.52	136007.63	7069.11	5.48%

Agriculture

- 46% of land area reported for land use statistics & 43% of TGA
- Net sown area:139.93mha & gross cropped area 194.39mha (2012/13 MoAFW)
- Increased cropping intensity



Area under agriculture

Costs of degradation

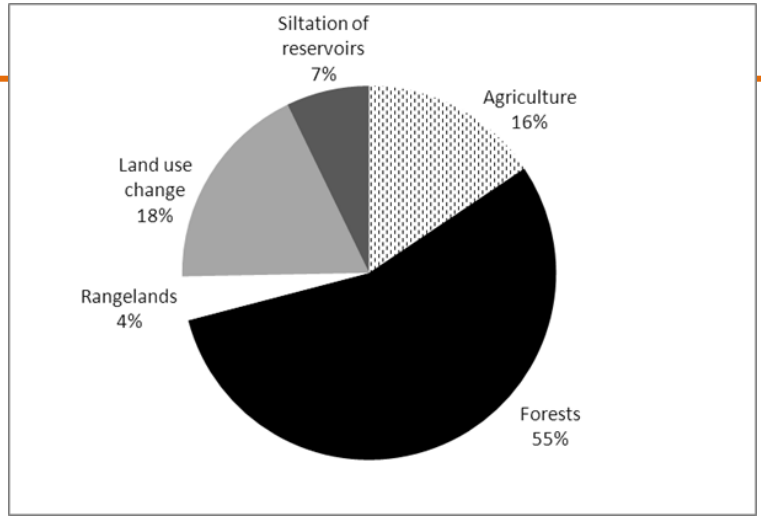
Results

	Category	Economic cost		
		Annual Value (Rs million in 2014/15 prices)	% of gross value added from agriculture and forestry (2014/15)	% of GDP (2014/15)
	Loss in agricultural production due to:			
1a	Water erosion			
	Onsite losses in rain-fed agriculture	208496	1.04	0.17
	Offsite losses	228585	1.15	0.18
1b	Sodic soils	162809	0.82	0.13
1c	Saline soils	86753	0.43	0.07
1d	Wind erosion	36675	0.18	0.03
1 (1a+1b+1c+1d)	Total agricultural loss	723319	3.63	0.58
2	Loss due to degradation of rangelands	120245	0.60	0.10
3	**Loss due to forest degradation**	**1758574**	**8.81**	**1.41**
4 (1+2+3)	**Total due to land degradation**	**2602138**	**13.04**	**2.08**
5	**Loss due to land use/cover change**	**575252**	**2.88**	**0.46**
6 (4+5)	Total cost of land degradation and land use change	3177390	15.92	**2.54**

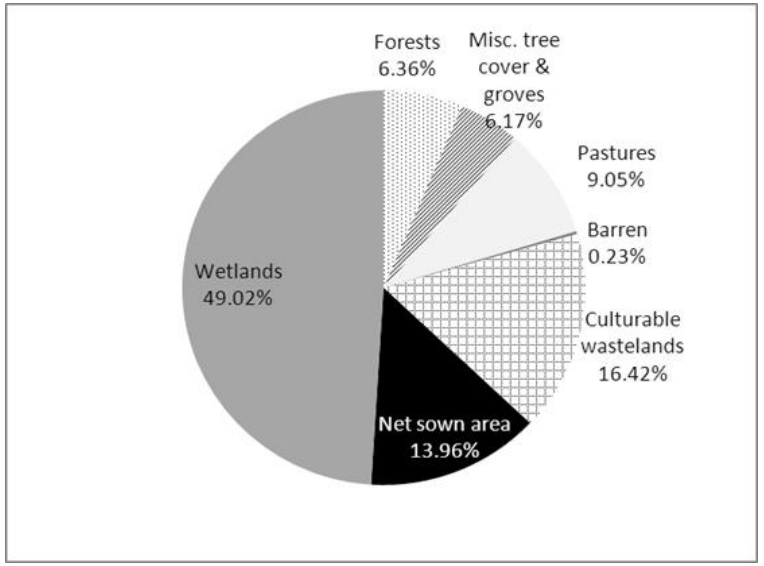
Main Findings

- 82% of cost due to land degradation;18% due to land use change-degradation of existing ecosystems
- Economic costs of forest degradation > 55% of total costs

Land (and sea) use change are the main drivers of ecosystem change.



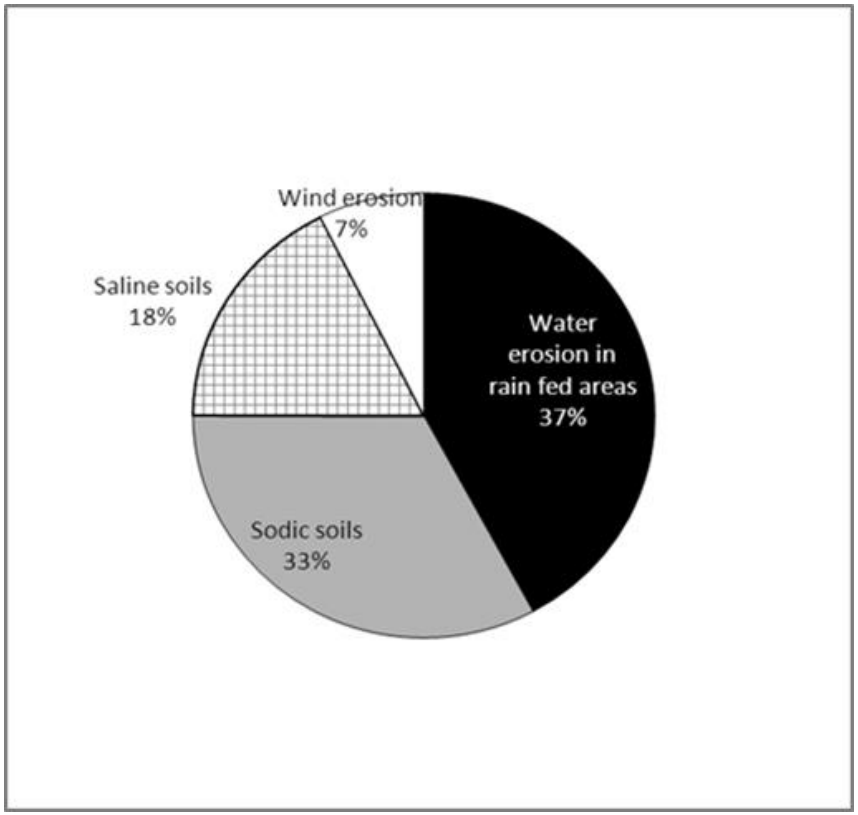
Costs of degradation



Costs of land-use change

Agriculture

- 16% of the total costs of LD and land use change
- 4% of GVA for agri sector
- Very conservative
  - Costs not estimated for cash crops in case of erosion
  - Water erosion only for rain-fed agriculture
  - No losses due to water logging



Agriculture costs by causal factor

Water erosion

- **On-site production losses in agriculture**
- Sharda et al (2010) - Indian Institute of Soil and Water Conservation
  - Only for rainfed areas

Crop	Potential eroded rainfed area ('00 ha)	Production loss (t)	Monetary loss (Rs. million) in 2014/15 prices*	%of total losses
Cereals	435489	8909483	**97725**	**47%**
Oilseeds	205507	2811192	**62124**	**30%**
Pulses	185556	1727367	**48647**	**23%**
Total	826552	13448042	**208496**	

- States with highest losses: **MP (17%), Karnataka, 16%, Maharashtra (12%) Andhra Pradesh (10%)**
- Off-site impact of soil erosion due to losses due to dam sedimentation: Rs 228.59 billion per year due to irrigation losses only. Losses due to impacted power supply, drinking water and flood control are additional.

Salinity & Sodicity

Sharma et al (2015) - Central Soil Salinity Research Institute

Crop	Crop area under sodic soils (ha)	Production losses (t)	Monetary loss (Rs. million) (in 2014/15 prices)
Cereals	4503289	5952677	86148
Oilseeds	789763	286809	11606
Pulses	684659	287339	8792
Cash crops	689910	4655904	56263
Total	6667621	11182729	162809

Production losses due to sodicity

50% cereals, 35% cash crops

UP (50%) & Gujarat (34%)

Crop	Crop area under sodic soils (ha)	Production losses (t)	Monetary loss (Rs. million) (in 2014/15 prices)
Cereals	2745306	2353757	32775
Oilseeds	770022	588764	24798
Pulses	650441	237304	7474
Cash crops	641860	2481444	21706
Total	4807629	5661269	86753

Production losses due to salinity

Cereals 38%, oilseeds 29%, Cash crops 25%, pulses 9%

Gujarat 61%, W. Bengal-15%

Sodic soils have high sodium content while saline soils have high salt content including of Calcium, Mg and carbonates

Loss due to wind erosion in Western Rajasthan

- Santra et al (2016) at the Central Arid Zone Research Institute
- Value of crop loss due to wind erosion estimated at Rs 36, 675 million in 2014-15 market prices

PROJECTING LAND DEGRADATION TRENDS IN 2030

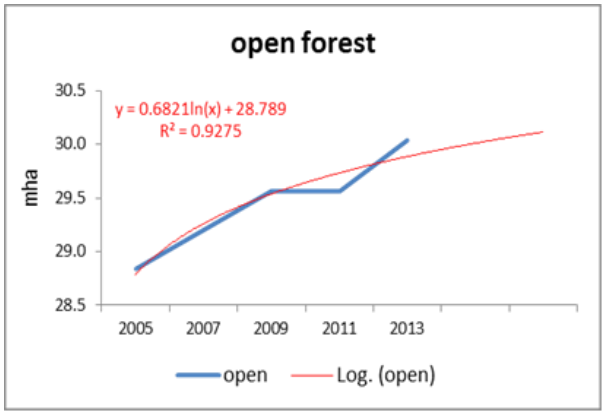
Land degradation in the future (2030)

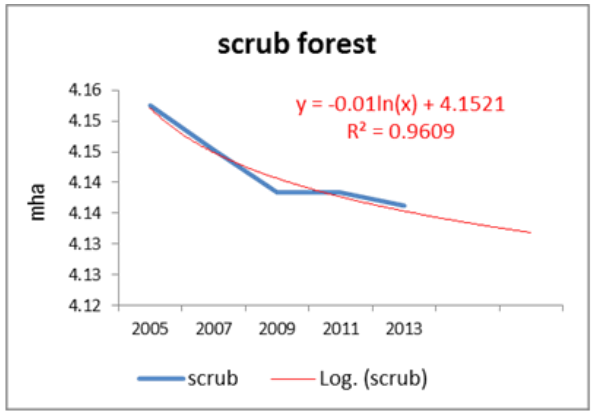
- Estimates based on extrapolation of past data but
- No consistent data sets giving physical estimates of land use change over time
- Land degradation categories fluctuate over time-ICAR & SAC
- Acid soils not mentioned in SAC (2016)
- Wasteland classifications different from LD ones
- Productive lands-e.g. marshy lands wastelands?
- Lack of consistency of figures (e.g. SAC 2007 and SAC 2016)

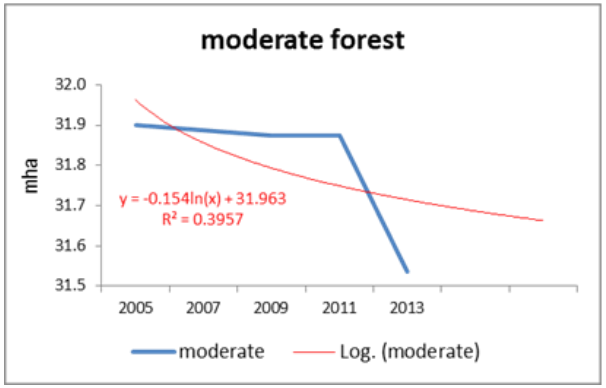
Scenarios

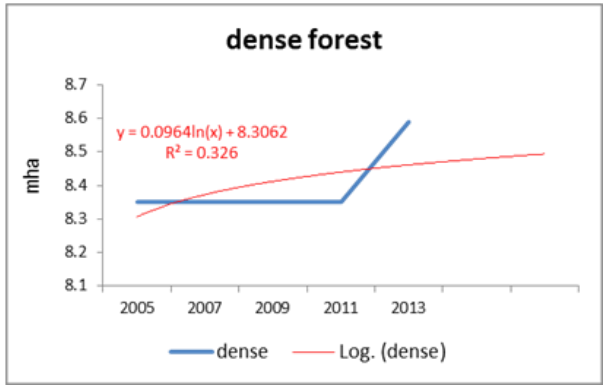
- 2 scenarios for water, wind, waterlogging and salinity
  - 2 data points (2003/05 and 2011/13) SAC (2016) assuming linear trends will continue over next 19 years till 2030
  - Longer time period but data from different sources, different methodologies
  - For forests, FSI data used over a 4 point period (2005-2015)

Forest scenario (same for 1& 2)







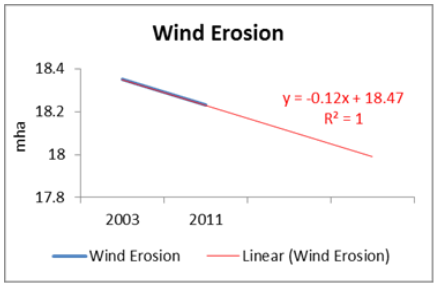


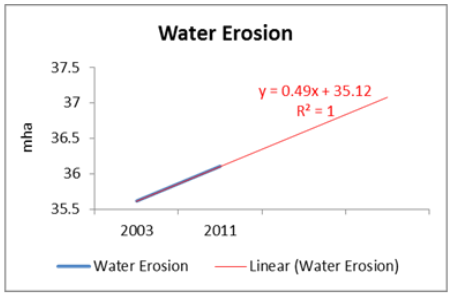
MDF decrease either due to upgradation to VDF forests or decline to open forests reflected by increase in open forests and in VDF

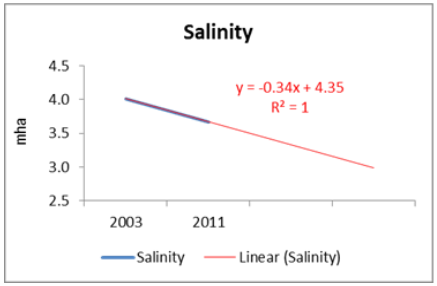
Upgradation of scrub and reduced conversion of other categories to scrub explains decrease in scrub over time

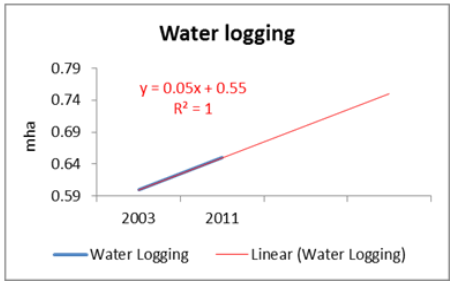
Past trend and future projections (till 2030) in Scenario 1 & 2

Scenario 1

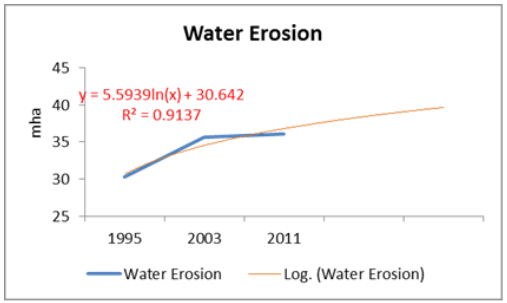


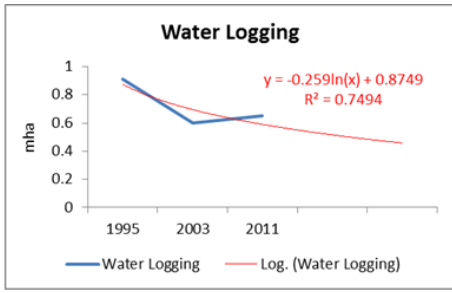


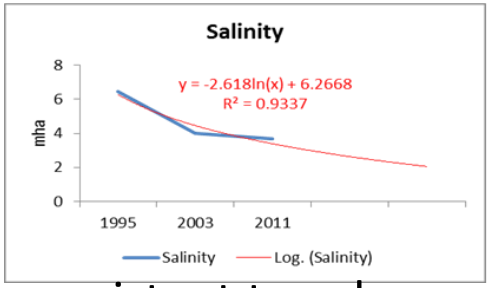


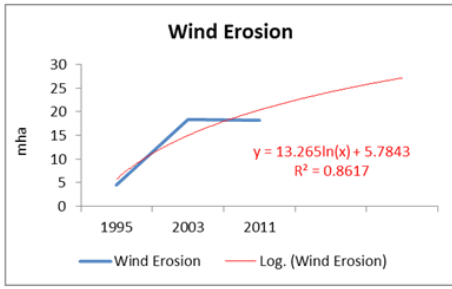


Scenario 2









- Only salinity and water erosion show consistent trends
- Addition of 1 data point reverses picture for wind erosion & water logging
- Values of degradation are higher in 2 since 2 predominant LD categories (water and wind)
- 2030: 94.53 mha & 106.15 mha
-

THE COSTS OF RECLAMATION

Costs of reclamation in 2030

- Per ha reclamation norms in 2014/15 prices
- Projected area

	Category	Amount (Rs/ha)	Year	Source
1	Saline/ alkaline	60000	2016	http:/ / agricoop.nic.in/ sites/ default/ files/ rps_guidelines%20 (2).pdf
2	Wind erosion		2005	Source: Chouhan, T.S. 2005. Degree, Extent and treatment of desertification hazards in India Sociedade & Natureza, vol. 1, núm. 1, mayo, 2005, pp. 901-919 Universidade Federal de Uberlândia
a)	arid	11000		
b)	semi-arid	11000		
c)	sub-humid	12000		
3	Water erosion		2016	Pradhan Mantri Krishi Sinchayee Yojna (2015)
a)	plains	12000		
b)	hills	15000		
4	Forests		2009	NAP, 2009 guidelines
a)	artificial regeneration (for open and scrub forests)	37085		
b)	natural regeneration (used as proxy for moderately dense forests)	27163		
5	Waterlogging		2013	http:/ / wrmin.nic.in/ writereaddata/ CAD-WL-20140331.pdf (XII plan)
a)	surface drainage	20000		
b)	SSD-Sub Surface Drainage	50,000		

Required investment in 2030

1	2	3	4	5	6
	Projected area in 2030 (in mha)		Cost of reclamation per ha (in 2014/ 15 prices)	Total investment (in Rs billion)	
	Scenario 1	Scenario 2		Scenario 1	Scenario 2
water erosion	39.04	40.15	15000	586	602
wind erosion	17.51	28.34	20812	364	590
water logging	0.95	0.43	50,000	48	22
salinity	1.63	1.81	60000	98	109
forests-scrub	4.12	4.12	52326	216	216
forests-open	31.28	31.28	52326	1637	1637
Total	94.53	106.15		2948	3175

***Annual* costs of degradation > *total* costs of reclamation in 2030 !**
(Rs 3177 billion > 3175 billion in scenario 2 and 2948 billion in 1)

It costs far less to reclaim land than it does to degrade it!

It makes economic sense to reclaim land-the Banni grassland case

- *Prosopis juliflora:* reduction in grassland productivity from 4000 kg/hectare in the 1960s to 620 kg/hectare in the early 2000s
- Adversely impacted the Maldhari milk economy
- 2 scenarios: BAU and *Prosopis* removal
- Livestock rearing- 95% of the income becomes uneconomical
- The per ha costs of land degradation estimated at INR 27,645 (USD 431),
- *Prosopis* removal led to a cumulative net total income increase of almost 7 billion rupees (2015-2030).
- A delay in *Prosopis* removal imposes a huge cost to the economy.

THE POLICY MESSAGE

The policy message

- Costs of degradation > costs of land use change: a)reducing further degradation of ecosystems and b) enhancing restoration of degraded ecosystems
- Costs of forest degradation highest impacts on the economy-300 million people dependent on forests: reducing forest dependence; NDCs
- 40% of the costs of loss of agricultural productivity borne by farmers in rain-fed areas & water erosion projected to increase
  - Watershed programme accounts for 58.4% of total expenditure for LD & 72% of land treated (2013) but water erosion leads in agricultural impact on the economy
- Need to scale up reclamation efforts particularly for water erosion, forest degradation and wind erosion (scenario 2)
- Need an integrative land use policy-forests, agriculture, water
- Wetlands should be included in the 9 category land use classification
- No grassland atlas

Consistent land estimates

- Need for longitudinal data sets consistently estimated to clarify trends
- Areal extent of ecosystems (e.g. grasslands). Natural forests vs plantations
- Definitional issues-what constitutes a wasteland
- Rationalisation of estimates




Thank You

https://www.teriin.org/project/study-economics-desertification-land-degradation-and-drought-dldd-india