FAO LCCS taxonomies for advancing the characterisation and description, monitoring and planning of land and water environments

Prof. Richard Lucas, Gregory Giuliani and Carole Planque*

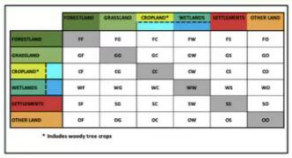
**Aberystwyth University, Aberystwyth, Ceredigion, UK*
University of Geneva, Geneva, Switzerland.

Overview

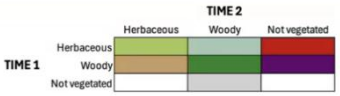
Land Cover

IPCC	FAO LCCS
FORESTLAND, GRASSLAND, CROPLAND, WETLAND, SETTLEMENT, OTHER LAND	

Land Cover Change







Flows and activities







Agriculture:	Ploughing, moving, pesticide application, crop establishment...
Forestry:	Planting, thinning, selective logging, clear cuts, clearing ....

The Intergovernmental Panel on Climate Change

Set up in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP).

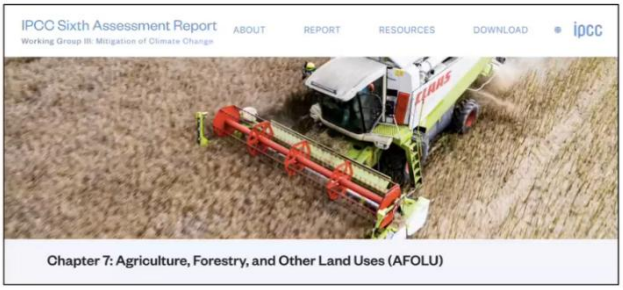
Its purpose is to inform decision-makers and provide the scientific basis for climate policy.

Includes policy negotiations under the UN's Framework Convention on Climate Change (UNFCCC).

Agriculture, Forestry and Other Land Use (AFOLU)

FORESTLAND | GRASSLAND | CROPLAND | WETLAND | SETTLEMENT | OTHER LAND

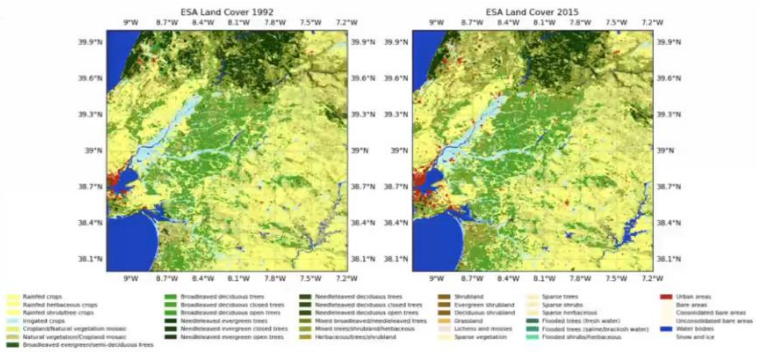
Penman, J., Gytarsky, M., Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K. & Wagner, F. (eds.) (2003). *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. IPCC National Greenhouse Gas Inventories Programme.



Nabuurs, G-J., R. Mrabet, A. Abu Hatab, M. Bustamante, H. Clark, P. Havlík, J. House, C. Mbow, K.N. Ninan, A. Popp, S. Roe, B. Sohngen, S. Towprayoon, 2022: Agriculture, Forestry and Other Land Uses (AFOLU). In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.009

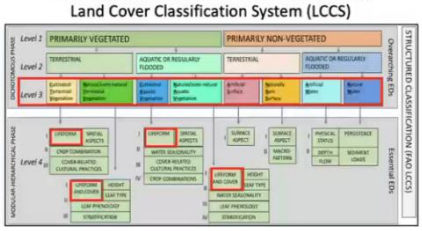
Mapping between land cover classes used in various legends.

IPCC	GLC-Share	SEEA	ESA CCI-LC classes (and codes)
FOREST LAND	Tree Covered Areas	Forest tree cover	Tree broadleaved evergreen, Tree broadleaved deciduous, Tree needle leaved evergreen, Tree needle leaved deciduous, Tree mixed leaf type, Mosaic tree, shrub / herbaceous cover, Tree flooded, fresh water
GRASS LAND	Grassland Shrub Covered Areas Sparse Vegetation	Pasture and natural grassland Shrubland, bushland, heathland Sparsely vegetated areas Natural vegetation associations and mosaics	Mosaic natural vegetation / cropland, Mosaic herbaceous cover / tree, shrub, Scrublands, Grassland, Lichens and mosses, Sparse vegetation
CROP LAND	Cropland	Medium to large fields of rain-fed herbaceous cropland Medium to large fields of irrigated herbaceous cropland Permanent crops, agriculture plantations Agriculture associations and mosaics	Cropland rain fed, Herbaceous cover Tree or shrub cover Cropland, irrigated or post-flooding, Mosaic cropland / natural vegetation
WET LAND	Herbaceous Vegetation, aquatic and regularly flooded Mangrove	Open wetland	Tree cover, flooded, saline water, Shrub or herbaceous cover, flooded Water bodies
SETTLEMENT	Artificial Surfaces	Urban and associated developed areas	Urban areas
OTHER LAND	Bare soil Snow and Glacier	Barren land Permanent snow and glaciers	Bare areas, Permanent snow and ice
	Water Bodies	Inland water bodies Coastland Water bodies Sea	



The Food and Agriculture Organisation (FAO) Land Cover Classification System (LCCS)





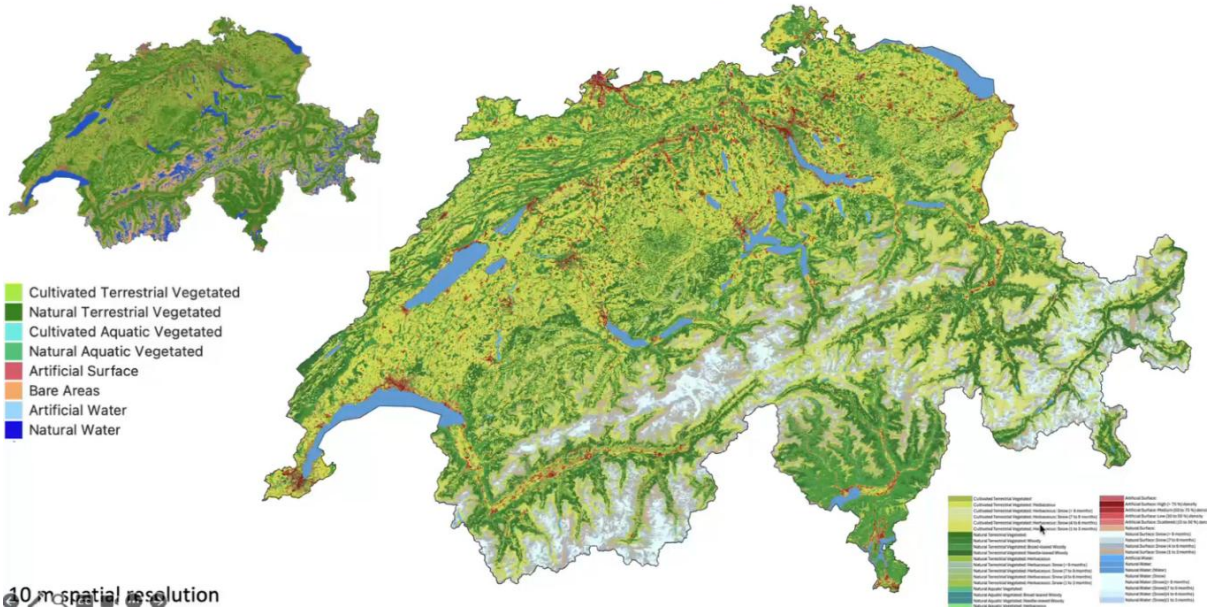
"There is a desire to harmonized nationally-defined legends to common global legends"

The FAO LCCS describes land cover through a dichotomous (to Level 3) and then modular hierarchical phase(referred to here as Level 4)

Most land cover classifications use the end classes (typically 20-60 for regional to global application) (see above)

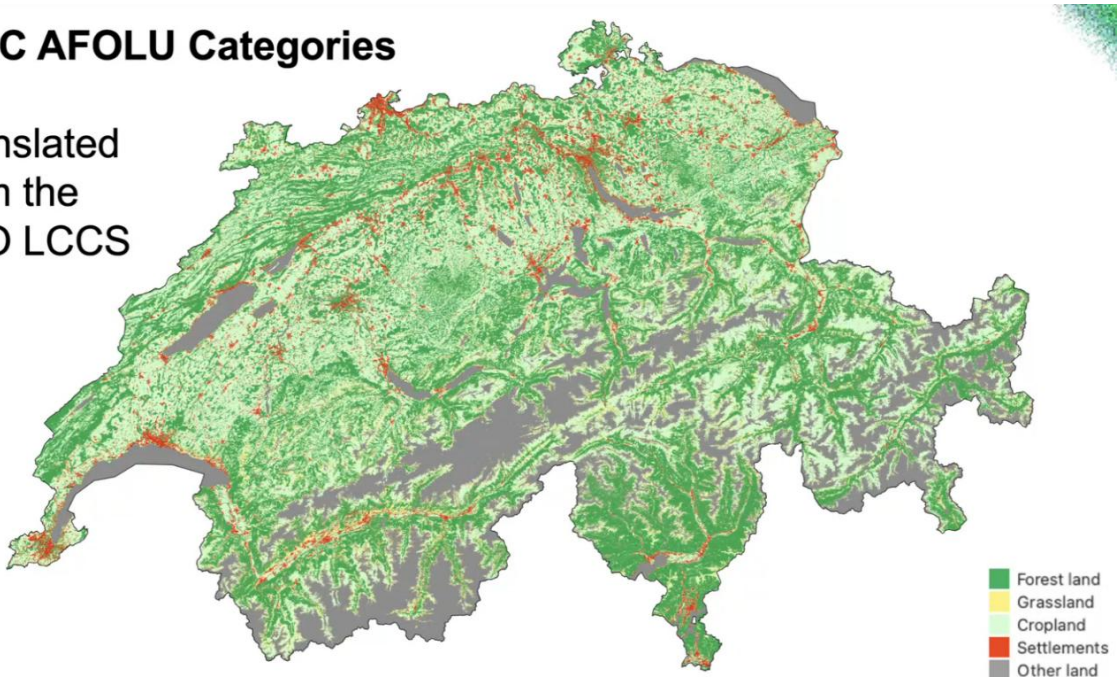
However, over **12,000** unique and meaningful classes can be described.

A National Land Cover Map for Switzerland

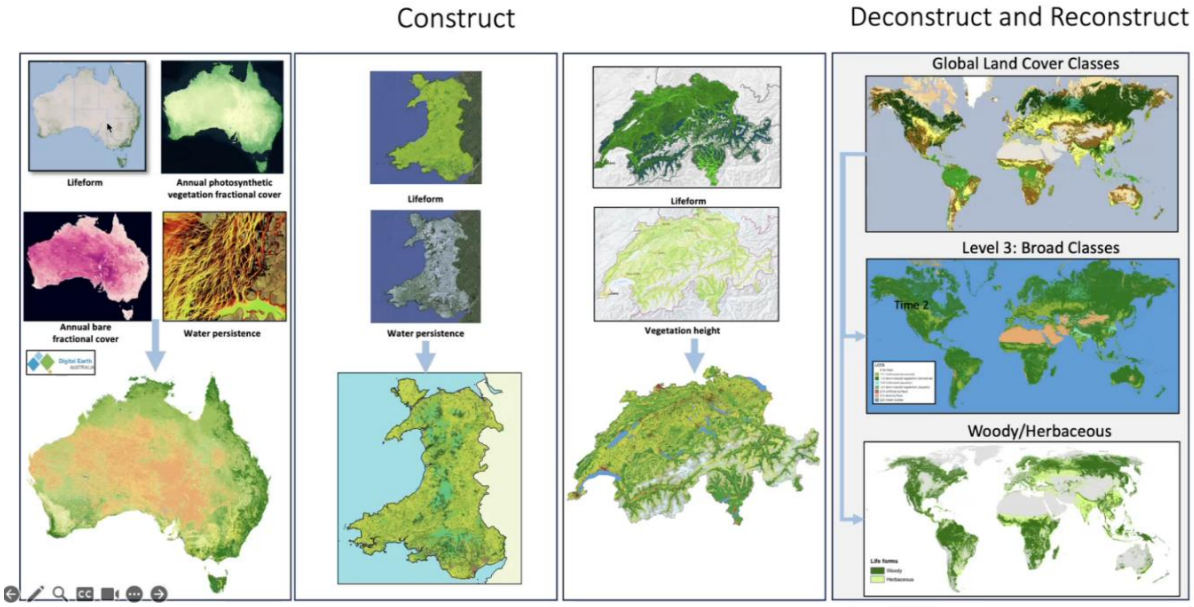


IPCC AFOLU Categories

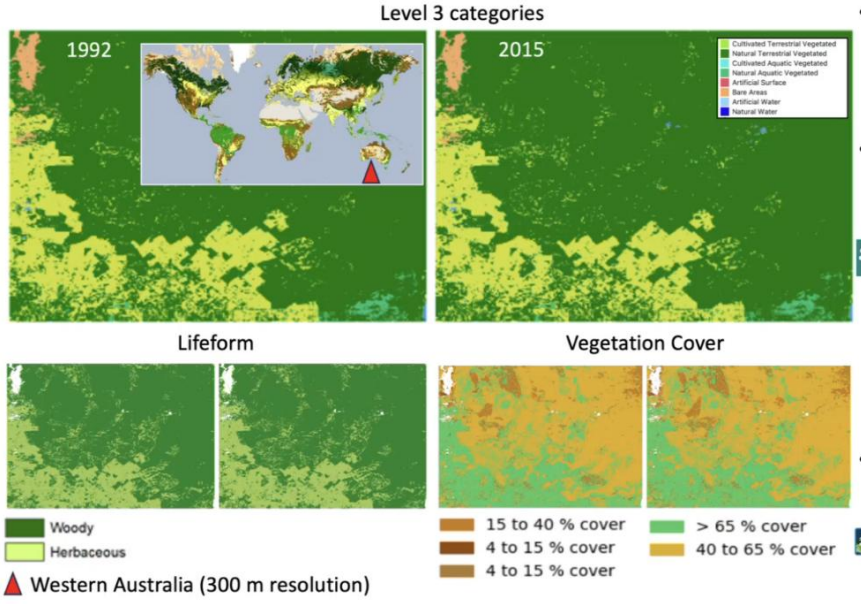
Translated from the FAO LCCS



FAO LCCS Classifications from Environmental Descriptors



Deconstructed Environmental Descriptors; ESA CCI Land Cover



- Most national (even local) to global maps can be deconstructed into the FAO LCCS.
- Maps external to these classifications can also be ingested:

Global Mangrove Watch
- Natural Aquatic Vegetation
- Lifeform: Woody
- Leaf type: Broadleaf
- Phenology: Evergreen
- Water state: Tidal

- Additional descriptors can be included:

ESA CCI Biomass
- Lifeform: Woody
- Above ground biomass

IPCC Major Land Cover Processes

Transition Matrix

Graphical summary of the land cover change matrix for the 6 IPCC classes (30 possible transitions).

Original Class	Forest Land	Grassland	Cropland	Wetlands	Settlements	Other Land
Forest Land	Stable	Vegetation loss	Deforestation	Inundation	Deforestation	Vegetation loss
Grassland	Afforestation	Stable	Agricultural expansion	Inundation	Urban expansion	Vegetation loss
Cropland	Afforestation	Withdrawal of Agriculture	Stable	Inundation	Urban expansion	Vegetation loss
Wetlands	Woody Encroachment	Wetland drainage	Wetland drainage	Stable	Wetland drainage	Wetland drainage
Settlements	Afforestation	Vegetation establishment	Agricultural expansion	Wetland establishment	Stable	Withdrawal of Settlements
Other Land	Afforestation	Vegetation establishment	Agricultural expansion	Wetland establishment	Urban expansion	Stable

Improvement

Stable

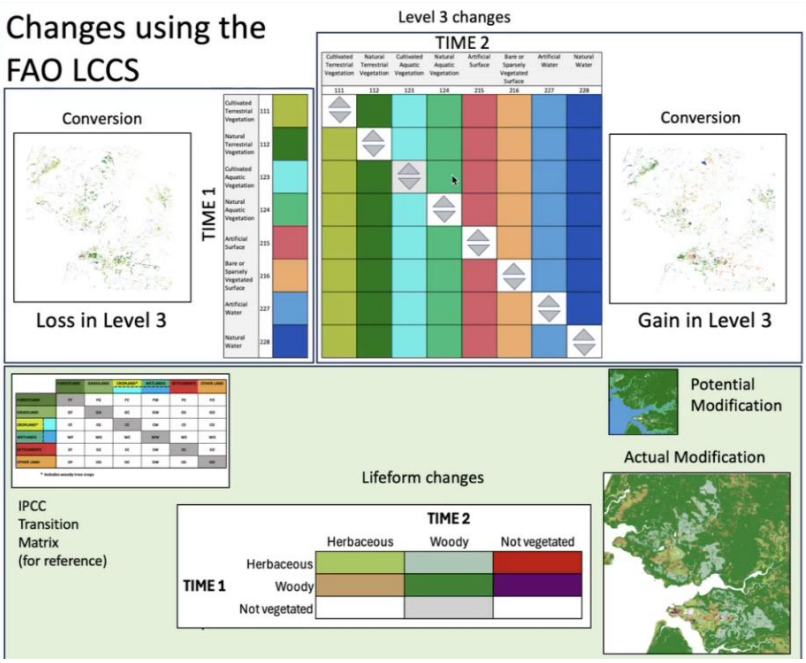
Degradation

Flows

The major land cover change processes identified in the flow diagram (opposite)

FLOW ID	FLOW PROCESS DESCRIPTION	DEGRADATION
LCF1	Deforestation	Yes
LCF2	Urban Expansion	Yes
LCF3	Vegetation Loss	Yes
LCF4	Inundation	Yes
LCF5	Wetland drainage	Yes
LCF6	Withdrawal of agriculture	Yes
LCF7	Stable	No
LCF8	Afforestation	No
LCF9	Agricultural Expansion	No
LCF10	Vegetation establishment	No
LCF11	Wetland Establishment	No

Changes using the FAO LCCS



Global Change Taxonomy



Impact categories (77)

Vegetation gain (extent)
Vegetation loss (extent)
Vegetation gain (amount)
Vegetation loss (amount)

Water gain (extent)
Water loss (extent)
Water gain (amount)
Water loss (amount)

Driving pressures (144)

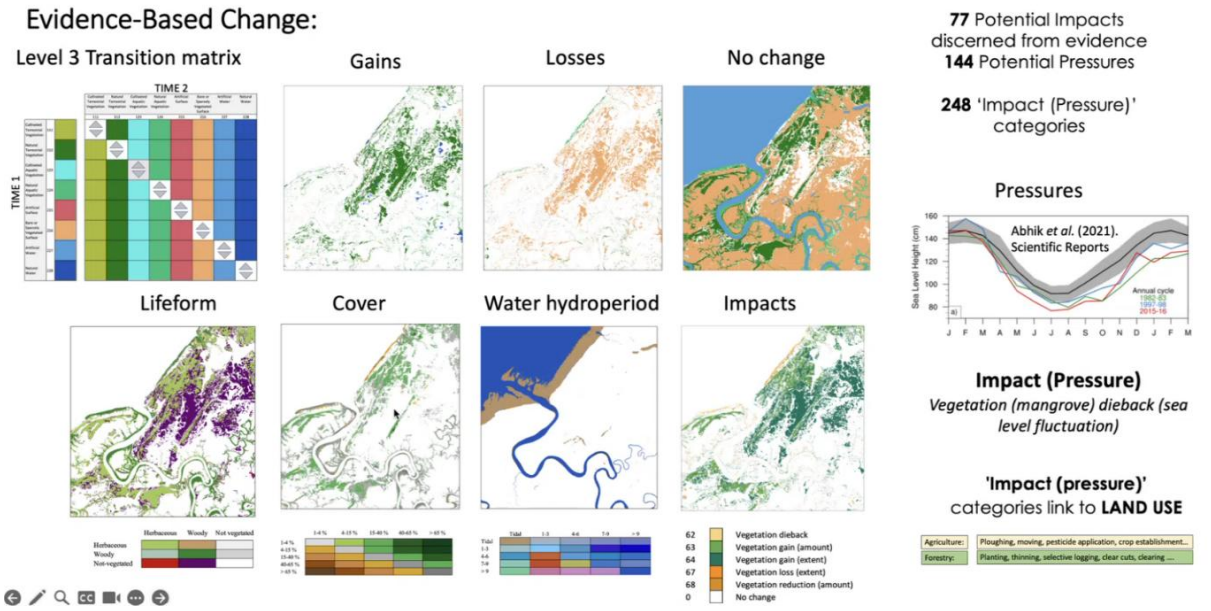
Agricultural expansion
Agricultural abandonment

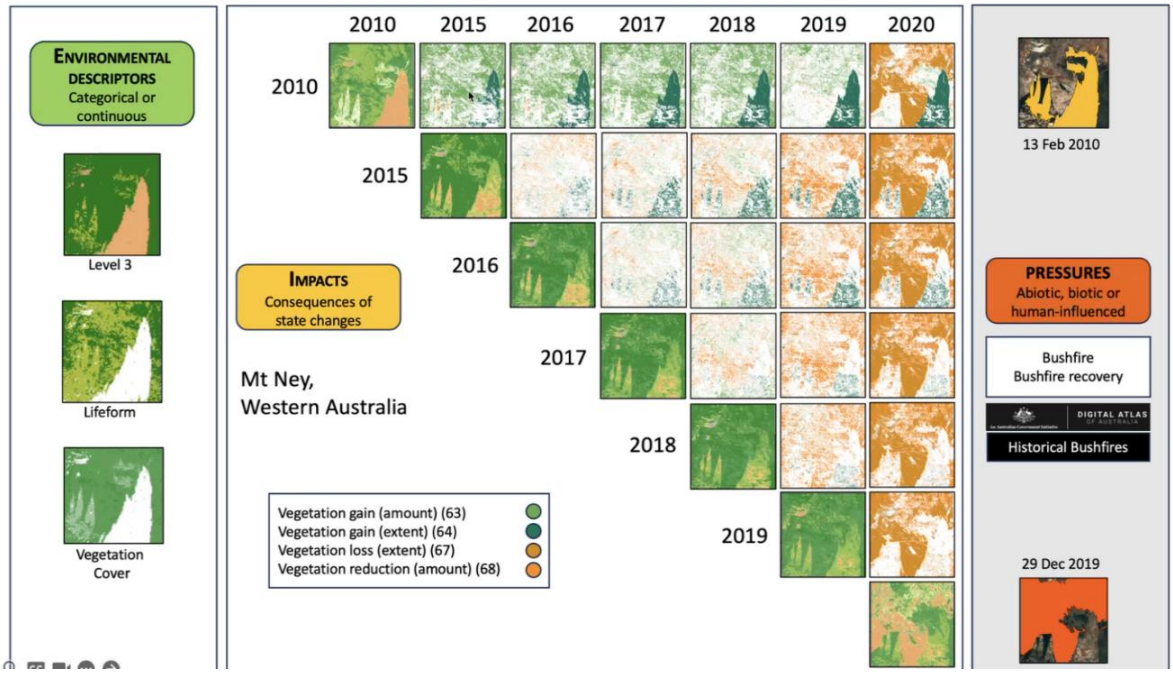
Deforestation
Afforestation
Reforestation/Planting

Urban expansion

Inundation
Wetland drainage

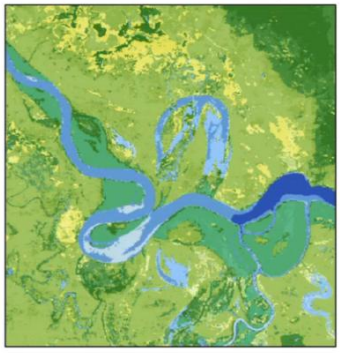
Example– Gulf of Carpentaria, Queensland



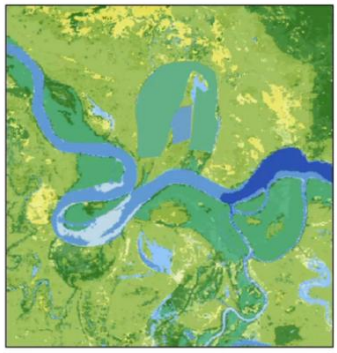


Using the FAO LCCS to Support Planning of Future Landscapes

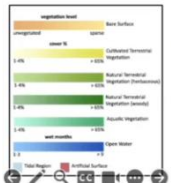
2020 Landscape

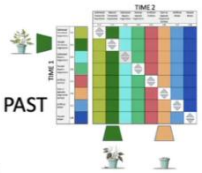


2030 Landscape

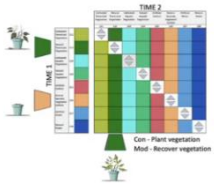


Lower Fitzroy Catchment, Queensland, Australia





PAST FUTURE



Attribution

LCCS	No.	Description
Level 3	124	Natural Aquatic Vegetation
Lifeform	1	Woody
Cover	12	40 to 60 %
Watersea	1	Tidal
Year	2030	By when
LCCS	A24.A1.A12.C1	

Sequential 'impacts (pressures)'

Flooding
Water extent (gain)

Colonisation
Vegetation extent (gain)

Growth
Veg. amount (gain)

Succession
Veg. species change

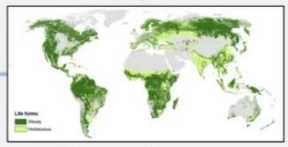
Simultaneous 'impacts (pressures)'

Future Landscapes: Components to Consider

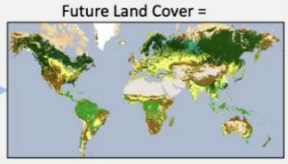
Level 3: Broad Classes



Woody/Herbaceous



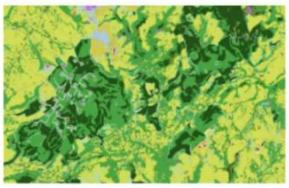
Future Land Cover =





(RE)IMAGINING

What would we like to see?



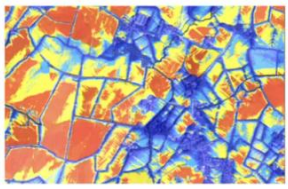
VALUING

How can we place a value on what we want?



ASSESSING RISK

How can we identify threats?



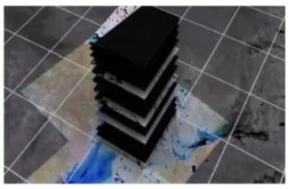
REALISING

How can we be certain?



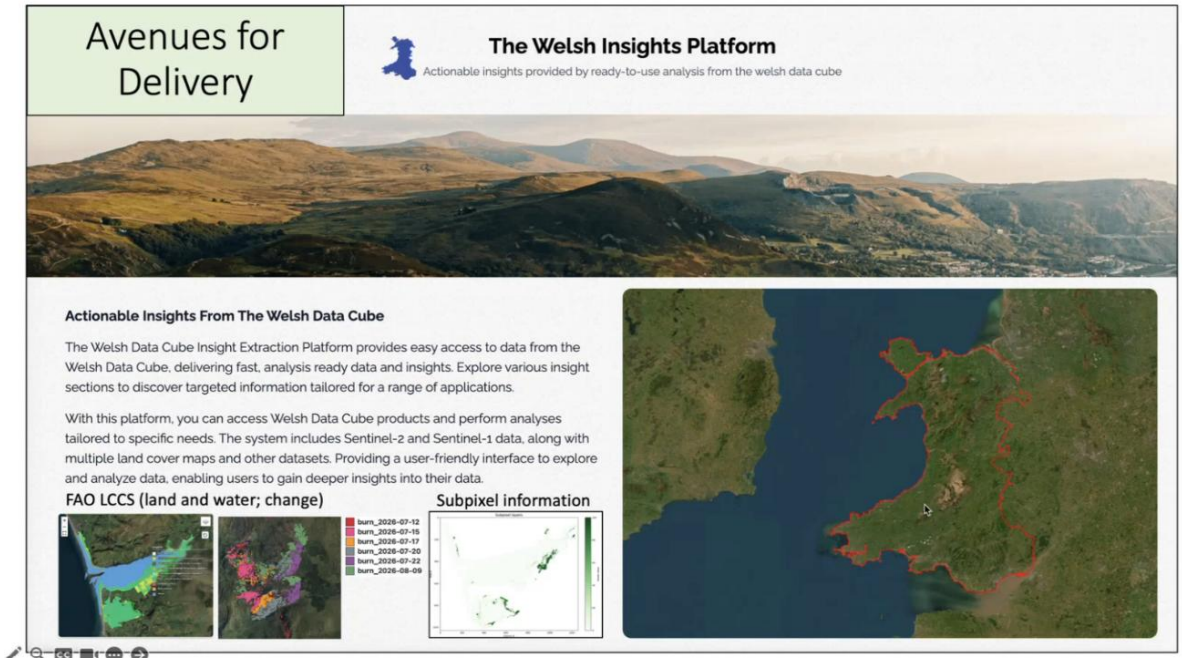
HARMONISING

How can we agree and co-design?



MONITORING

How can we track progress towards our ambitions?



Summary

1. The FAO LCCS Level 3 and lifeform classes, in combination, directly translate to the 6 overarching IPCC classes.
2. Maps of FAO LCCS classes can be constructed from Environmental Descriptors (EDs), with this demonstrated at country levels and for multiple (annual_ time steps
    1. Australia
    2. Wales (UK)
    3. Switzerland
3. Existing land cover products, global through to national (including sub-national) can be deconstructed to these EDs and reconstructed into the FAO LCCS.
    1. 30 m, 1985 to 2025 going forward
4. External EDs (e.g., Global Mangrove Watch) can be easily integrated and used to replace currently used EDs or improve descriptions of mapped classes (e.g., global biomass products).
5. 77 impact classes listed within the Global Change Taxonomy (GCT) can be mapped based on evidence accumulated through time-series comparisons of the EDs used to construct maps of and describe land and water.
6. Evidence from the 144 pressure categories can be obtained from a range of sources, including comparisons of the land cover maps themselves (e.g., changes in water persistence, vegetation cover) or from external layers (e.g., climate etc.)
7. The IPCC flow definitions mix impacts and pressures, which are separated in the GCT.
8. The association of impacts and pressures increases the capacity to describe changes and provides land use information.
9. The FAO LCCS and GCT can be used to support planning of future landscapes (from sub-national to global levels) and monitoring progress towards achievement.
10. Options for delivery at national scales being explored (demonstrated for Wales, UK)