CHAPTER 20

LAND COVER AND GLOBAL CHANGE
BREAKOUT SESSION REPORT
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Like many key issues in climate change, land cover is both a driver and an indicator. The National Research Council has identified land use dynamics as one of the grand challenges for environmental research. No other global change parameter is so tightly intertwined with the issues of past, present and future land use practices; weather patterns; soil and carbon dynamics; ecosystem health and diversity; human population size and distribution; economic development and policy; technology and human health.

The importance of land cover interactions is further recognized in the stated goal of the International Geosphere-Biosphere Programme (IGBP) Global Land Project: "to measure, model and understand the coupled socioenvironmental terrestrial system." However, a lack of quantitative understanding of the timing and magnitudes of the response of ecological, social and economic systems to the combined effects of climate change and **land cover/land use** change are cited in the IPCC's Third Assessment Report as key uncertainties in understanding vulnerabilities and predicting both regional and global impacts of climate change.

The Land Cover and Global Change breakout group discussed issues that ranged from the use, development and preservation of land cover data to reach a better understanding of climate change locally, regionally, and worldwide, to practical issues like cross-boundary access to data and decision support tools. The group identified six critical land cover needs and issues of importance for climate change research: 1) the need to develop and work to international standards; 2) the importance of distinguishing between land cover and land use; 3) the need for quick turnaround in data collection and dissemination; 4) the need to identify and preserve at-risk archives of historical data; 5) the need for continuity and consistency; and 6) issues related to national data policies. These are summarized below.

1. Cross-walking classifications to international standards

"What is a tree?" Breakout participants acknowledged that different organizations use different classification standards, terminology, and ground truth frequencies and scales depending upon the type of analysis at hand. Classification systems vary depending upon the objectives and needs of the country, agency, or research entity that developed them. In most cases these are well-established systems that serve their users' needs well so the likelihood of any agency or group changing their classification to accommodate international standards is therefore small. However, the lack of a consistent system across jurisdictional boundaries makes global interpretation and synthesis difficult.

How can we put datasets together that are compatible globally, nationally, and regionally, to assemble a common baseline and consistent measures of change? The Food and Agriculture Organization's Land Cover Classification System (LCCS) represents a major attempt to develop a unified land cover classification protocol. While it is unlikely that major national efforts will be in a position to change their well-functioning internal classification schemes, breakout participants agreed that it should be feasible, without compromising agency requirements, to crosswalk those classification schemes to an international standard like the LCCS.

Similarly but at a higher level, there is a need for standardization or the development of methodologies for crosswalking in satellite and airborne sensors, delivery systems, and tools. The Landsat and Landsat Data Continuity Mission (LDCM) communities have been working hard to have both consistent metadata and data collection standards and product exchange from any station around the world. However, since many sensor systems and protocols are used worldwide, there is a clear need for the development of methods to make data and analyses compatible with one another for global change studies.

2. Land Cover Data vs. Land Use Data

While the terms *land cover* and *land use* are often used interchangeably, they are very different concepts. Which one is used usually depends upon the discipline doing the study and the desired goal of the study. In general terms, land cover is what is on the ground; land use is the effect of human activity on the landscape. Delineation of land cover classes can vary depending upon the discipline in which a study is conducted. Even the choice of *land cover* versus *land use* is dependent upon the intended application of the data (agriculture studies, for example, may use either). There are also studies in which the two are blended with varying degrees of consistency and accuracy (water, for instance, can be either a land cover class or a land use class). In some landscapes (e.g. African savannas), human activity has been so persistent over so long a time that it becomes problematic to tease land cover apart from land use.

In Australia, the paradigm often used is that *land cover* is what can be seen from photo or satellite interpretation, i.e. the characteristics of the land that can affect albedo, while *land use* is what is actually done to the land by people. Taking the analysis further, the Australian approach looks at *land use* along a continuum that identifies level of intervention and delineates five major carbon classes – national parks (where there is very little intervention), followed by natural environments, forestry areas, dryland activities, and finally irrigated activities (where intervention is very high). After *land cover* and *land use*, the next important tier of data to collect is *land use practices* and *land disturbance*. All of these quantities are important as inputs for climate change modeling.

Another aspect of land cover and land use information for climate change studies is the need for consistent and comparable time series data. Understanding climate change at regional scales requires high accuracy data (3% error is very large for climate change), and in some cases high resolution data products. Producing data of this type and quality is intensive, requiring substantial efforts to align and correct the data.

Ultimately, climate change studies need time series, plus high resolution, high-accuracy information on surface dynamics - not just land use classes, but disturbances. Breakout participants agreed that more research and different perspectives are needed to understand what data are needed for understanding climate change.

3. Quicker Turnaround on Global Dataset Generation

Participants agreed that quicker turnaround than that presently available is needed if global datasets are to be useful in more than academic exercises. Decadal datasets take so long to be released that they are obsolete before they become available, and their utility is therefore limited to retrospective studies. There is such a great need for rapid-turnaround mid-decadal data series for global climate modeling and analyses that participants felt that sacrificing some aspects of data quality (e.g. accepting some spatial data gaps, higher cloud cover) would be appropriate if it brought the datasets into the hands of scientists in time to be of use.

4. Preservation and Accessibility of Archival Data

Part of understanding global change is understanding how things have changed in the past. Landsat data provide a window on more than 30 years of change, but satellite data are not generally available for dates prior to the early 1970's. However, much information can be gained from historical aerial photography and ground-based images, providing those data are made available. Participants noted the existence of large collections of aerial photography acquired before, during and after World War II, as well as images acquired for soil surveys and other purposes over many decades. Historical map information can also provide insights and details on land use and change.

While some of these images are in public archives, a great many remain in private hands. Many public and private archives are at risk of data loss due to the ageing of photographic films, paper, and ancillary data and the lack of resources for preservation. The information these sources can contribute to understanding landscape change through time is immense. Breakout participants agreed that resources are needed and should be found to (at a minimum) catalog, store, and make metadata available for these archival materials, and to scan and georeference materials of high importance.

5. Continuity and Consistency of Data

Touched upon in the sections above are the overarching issues of data continuity and data consistency, in both the spatial and temporal domains. Global change research and especially climate change modeling are dependent upon the continued availability of consistent time series data from comparable sensors and sources, with consistent metadata and ground truth information that has been collected with uniform or at least comparable terminology, granularity, and parameterization.

Some of the difficulties in assembling global or even regional and transnational datasets have been addressed in the sections above. There is a great need for standardization of units, definitions, and ground truth. Otherwise, crosswalking to a common classification rubric becomes an exercise in futility. The need for consistency ranges from such fundamental observations as the minimum height that woody vegetation must attain to be called a tree; to the consistent description and definition of each land cover or land use class (e.g. exactly how is *mixed forest* defined?); to the total number, independence, and character of classes used.

At another level entirely is the need for eventual consistency across climate models and coupled models themselves, so that model results are comparable and that the results of one model can serve as inputs to the next. Modeling of this type is still maturing and is strongly dependent upon what question(s) the model is intended to answer. Providing the correct input data at the correct spatial and temporal scales is crucial to the success and validity of the results. This goal can best be achieved through joint and cooperative efforts between the modeling and land cover communities.

6. Fundamental Differences in Data Policies

Breakout session participants generally agreed that differences in data policies hinder transboundary and regional monitoring, research, and modeling. At the national level, data policy and access to land use and land cover data varies: U.S. land use-land cover data are available to everyone at no cost, while Mexico and Canada each have particular copyright issues that are often compounded by legislative requirements for cost recovery. In addition, though these data would be of inestimable value as ground truth and as model inputs, there are privacy issues associated with land use and land cover data at the parcel or individual landowner level. Taken together, these issues hamper transboundary efforts.

Participants offered suggestions on ways to address these issues. There was consensus that while sweeping changes to national policy are hard to achieve, it is very possible to be successful in developing agreements to address specific problems in specific locations. Furthermore, it is important to elucidate what the most important data are and to work towards cooperation with those specific data needs in mind. These interactions take place at the human rather than governmental scale, beginning with dialogue and inclusion of stakeholders. Effective international cooperation requires patience, persistence, and good will not only to achieve the immediate objectives of a project, but to nurture the likelihood of adoption of mutually accepted standards and policies that will benefit all parties.

Participants

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