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Report

## Meeting in the middle: the challenge of meso-level integration

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One of the main challenges facing the land-use/cover change research community is the forging of robust linkages between the fine-grained understandings of land-use decisions and broad-scale models of land cover. A number of projects have undertaken this challenge in particular regions, and it is now time to derive lessons from these experiences to facilitate future communication between these two groups. In order to address this issue, an international workshop was organized in Ispra, Italy, October 17–20, 2000 by the Land Use and Cover Change (LUCC) Project (<http://www.indiana.edu/~act/focus1/>), a programme element of the International Geosphere–Biosphere Programme, and the International Human Dimensions Programme on Global Environmental Change.<sup>1</sup>

The purpose of the workshop was to enhance collaboration between those who study household decision-making and its land-cover consequences, and those who seek to explain broader-scale land cover through socio-economic driving forces. It has been proposed that the meeting place of these two groups lies at the regional scale, representing both the “upper limit” (maximum extent) of the survey-based land-use analyses and the “lower limit” (finest grain) of land-cover analyses based on the currently available remote-sensing data.

The workshop had the following objectives:

- To Specify the problems entailed in integrating land-use and land-cover classifications;

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<sup>1</sup>The workshop was hosted by the Global Vegetation Monitoring Unit of the European Commission Joint Research Centre’s Space Applications Institute, with support from the US National Science Foundation’s Directorate for Social, Behavioural and Economic Sciences, the US National Aeronautics and Space Administration’s Land Cover and Land Use Change Project and Indiana University’s Office of Research and Graduate School. Participants included representatives of a dozen LUCC Endorsed Projects, the U.N. Food and Agricultural Organization’s Sustainable Development Department and Africover Project, the US Geological Survey, and the European Environment Agency’s Topic Centre on Land Cover.

- To Ascertain the effectiveness of approaches used to date to overcome such problems; and
- To Evaluate the utility of the FAO’s recently completed Land Cover Classification System (LCCS) as a vehicle for integration.

Much of the discussion at the workshop centred on the multitude of schemes for characterizing, or “classifying” land use and land cover. Because the land-use studies begin with the particularities of place, culture and local environment, the categories used tend to be unique, and difficult to aggregate in order to fit neatly into more broadly applicable classification schemes. The converse is true of land-cover studies, which utilize data that indicate broad land-cover types, and from which land use can only be inferred by context and verified through ground-truthing. The challenge is thus to come to an agreement on classification schemes that translate seamlessly between scales of analysis.

Efforts to harmonize land-cover classification have been under way for the last decade, with an international consortium led by the UN FAO’s Sustainable Development Department, leading to the development of a methodology known as the LCCS. This methodology has been operationalized under the aegis of the FAO’s Africover project, resulting in a software application. The LCCS software allows for the specification of mutually exclusive land-cover classes within a hierarchical and universal framework, as well as the translation of pre-existing land-cover classifications.<sup>2</sup> *Meeting in the Middle* participants were provided with copies of the software, and much of the discussion at the workshop centred on the participants’ assessments of the degree to which LCCS enabled the recording of the kinds of information they might typically use in local or regional land-use and cover change studies, and the extent to which it might facilitate harmonization.

<sup>2</sup>Copies of the Land Cover Classification System software and user’s manual can be obtained from the Africover Project (e-mail: <mailto:info@africover.org>; on the web at: <http://www.lccs-info.org/>).

- 1 The conclusions of the workshop were as follows<sup>3</sup>:  
 2 (1) Recent developments in earth observation and  
 3 analysis make the harmonization of land-use and cover  
 4 information a practical necessity; at the same time, a  
 5 tool has just become available that promises to achieve a  
 6 major part of the harmonization.  
 7 Land-cover mapping is quickly approaching a sort of  
 8 convergence, as reliable global products at ever-finer  
 9 spatial resolutions become available, and high-spatial  
 10 resolution efforts cover increasingly larger parts of the  
 11 globe. As the linkage of these various perspectives  
 12 becomes more practical, the issue of land-use and cover  
 13 harmonization is raised to one of operational necessity.  
 14 The search for a standardized classification scheme  
 15 for land use and land cover has a long history, and the  
 16 need has been increasingly recognized over the last  
 17 decade, with two United Nations agencies, UNEP/  
 18 GEMS and FAO, taking the lead in organizing expert  
 19 meetings to build an international coalition to develop a  
 20 solution. By the time the need for harmonization was  
 21 recognized in the LUCS Science Plan in 1995, the FAO-  
 22 led effort had achieved good progress in developing a  
 23 conceptual framework. The Meeting in the Middle  
 24 Workshop coincided with the release of Version 1 of the  
 25 FAO's LCCS software—a software implementation of  
 26 this conceptual framework. The LCCS is intended to be  
 27 a universal land-cover classification scheme that will  
 28 enable the translation of any and all prior or future  
 29 classifications into a universal framework (nomencla-  
 30 ture/coding). In part, the Meeting in the Middle  
 31 Workshop was designed to enable participants to  
 32 evaluate the LCCS product, and to make appropriate  
 33 recommendations to the LUCS community. Further,  
 34 the Workshop was intended to make recommendations  
 35 concerning future efforts.
- 36 (2) The full, universal, harmonization of land-use and  
 37 cover information is quite a difficult and perhaps  
 38 impossible undertaking, which faces significant obsta-  
 39 cles, including varied and insufficiently specified user  
 40 needs and long-standing theoretical and practical dis-  
 41 ciplinary.
- 42 There exists a broad range of constituencies for land-  
 43 cover information, which have not been specified to the  
 44 degree required to judge how any one classification  
 45 scheme might serve these varied interests.
- 46 What has become quite evident is that distilling  
 47 research findings extending across local and global  
 48 research perspectives, different study areas, and for a  
 49 host of space-time scales is critical to understanding how  
 50 land use and land cover varied in the past, how they are  
 51 organized today, and how they may vary in the future?  
 52 To understand the pattern is to understand the form,  
 53 and hence efforts at classification harmonization moves  
 54 us closer to the time when we can use land use and land  
 55 cover as signatures of biophysical processes as well as  
 56 keys to deciphering the influence of the human dimen-  
 57 sion of landscape structure.  
 58 The different approaches for land-use change research  
 59 reflect differences in world view that underlie how  
 60 people explain the functioning of complex systems. A  
 61 more integrated approach, blending processes and  
 62 structures at several scales, including their interactions,  
 63 should become the norm in land-use change research.  
 64 Such an approach should recognize land-use dynamics  
 65 derived from the interaction of processes and structures  
 66 at scales ranging from the individual tree to the patch,  
 67 region, and even globe. A pluralism of emphasis, from  
 68 individual-based to regional/global models will continue  
 69 to be useful for addressing problems at multiple scales,  
 70 with meta-modelling used when linkage is needed. To  
 71 achieve this is a true challenge and requires researchers  
 72 to step beyond their disciplinary traditions.  
 73 The important aspect of linking case studies may be to  
 74 integrate the understanding about process, but not  
 75 necessarily to integrate land-cover or land-use informa-  
 76 tion, per se.  
 77 (3) The FAO LCCS was found to be a quite useful  
 78 tool based upon a well-thought-out strategy for  
 79 harmonizing land-cover classification.  
 80 In the early stages of the GEMS/FAO effort, the  
 81 standardization of both land-use and land cover were  
 82 under consideration, but the two became separated and  
 83 pursued independently. The land-use and land-cover  
 84 efforts took distinct conceptual paths: while the land-use  
 85 classification effort moved towards the development of a  
 86 glossary of land-use descriptors, the land-cover classifi-  
 87 cation effort adopted the conceptual stance that  
 88 standardization cannot be achieved in the realm of  
 89 description; rather that standardization must focus on  
 90 specific attributes of land covers, and should strive to  
 91 develop a set of classifiers that would unambiguously  
 92 differentiate classes. A fundamental set of classifiers was  
 93 assembled and placed in a logical (hierarchical) frame-  
 94 work, and a protocol was established for the para-  
 95 meterization (gradient breaks) of each of those  
 96 classifiers. The resulting classification system can be  
 97 used to develop legends of different degrees of specifi-  
 98 city, but which can, therefore, be logically aggregated  
 99 (generalized) until comparability is achieved.  
 100 (4) Despite having been designed primarily to  
 101 harmonize the classification of land cover, LCCS in  
 102 fact incorporates a certain number of land-use attri-  
 103 butes, particularly concerning agricultural land manage-  
 104 ment practices. Several suggestions for improving the  
 105 software's capabilities in this regard were offered and  
 106 received in a positive light by FAO. It was generally

<sup>3</sup>McConnell, W., E. Moran (Eds.), 2000. *Meeting in the Middle: The challenge of Meso-Level Integration. LUCS Report Series No. 5*. Bloomington, In: LUCS Focus 1 Office. Copies may be obtained from the LUCS Focus 1 Office (e-mail: [emailto:focus1@indiana.edu](mailto:emailto:focus1@indiana.edu)), and more information and a PDF version of the report can be found on the Focus 1 website: <http://www.indiana.edu/~act/focus1/>.

1 concluded that LCCS should not—at least in the short-  
 2 term—be expanded to encompass a full range of land-  
 3 use attributes; perhaps, a separate, but linked system  
 should be developed.

4 Land-use characteristics, including management prac-  
 5 tices such as water supply control, and frequency of  
 6 cultivation, are included in LCCS as environmental  
 7 attributes of “cultivated and managed areas.” Some  
 8 problems were encountered in specifying such attributes,  
 9 for example, the system currently expects the user to  
 10 classify fallow fields under the broad class of “primarily  
 11 non-vegetated areas”, while fields currently being  
 12 cultivated are expected to be classified under “primarily  
 13 vegetated areas”. The land-use researcher wants to be  
 14 able to classify these lands as essentially similar—as two  
 15 fields that just happen to be in different stages of the  
 16 rotation at the time of classification. This speaks for  
 17 broader issues of the capture of temporal information  
 18 for which the LCCS has limited capabilities.

19 Furthermore, while it is possible for the individual  
 20 user to add practically any other land-use attributes  
 21 desired, this must be done in an ad hoc fashion, resulting  
 22 in incompatibility. This was judged an unacceptable  
 23 long-term solution. In terms of expanding the capabil-  
 24 ities of the LCCS to handle land-use information, it was  
 25 noted that each new classifier that is added—especially  
 26 at higher levels—increases the number of possible  
 27 eventual classes, and thus the complexity of the system,  
 28 significantly. Furthermore, it was noted that while the  
 29 hierarchical arrangement of biophysical (esp. structural  
 30 vegetation) characteristics was relatively straight-for-  
 31 ward, a similar effort in the land-use domain is likely to  
 32 be much more difficult, since the relative importance of  
 33 management practices varies so widely across regions.

34 (5) While the harmonization of land COVER  
 35 classifications has been a major undertaking, land  
 36 USE poses an even greater challenge, not least because  
 37 of a lack of consensus on the meaning of land use (is it  
 38 the process that explains—and is explained by—land-

cover pattern, or does it encompass intentions, desires,  
 attitudes, beliefs, constraints, opportunities, etc.?).

41 The workshop discussions revealed a lack of con-  
 42 sensus on the precise definition of land use and  
 43 concluded that the distinction between land *use* from  
 44 land *cover* is still problematic. Getting land-use  
 45 researchers to agree on a fundamental set of land-use  
 46 attributes, from which classifiers can be operationalized,  
 47 is going to be a MAJOR undertaking, since there is even  
 48 difficulty in distinguishing land uses from driving forces.  
 49 The conflation of driving forces with land use is a  
 50 significant issue. At the extreme, it is not always clear as  
 51 to what is the “dependent variable” in land-use studies.  
 52 One school of thought holds that land uses cannot be  
 53 usefully described without reference to the socio-  
 54 environmental factors that govern the way the land is  
 55 used (e.g., access regime). The workshop participants  
 56 felt that any harmonization would be incomplete if  
 57 information on driving forces were not considered, and  
 58 perhaps central. In fact, one view holds that the needs of  
 59 the different research communities are so diverse that  
 60 harmonization of all aspects of land-use classification  
 61 will ultimately be unsuccessful, and that effort should be  
 62 focused solely on harmonizing information concerning  
 63 the driving forces of land use.

## 64 Conclusion 65

66 In conclusion, the Lucc Scientific Steering Commit-  
 67 tee has encouraged the Lucc community to further  
 68 explore the utility of the LCCS methodology and  
 69 software for land-cover harmonization, and welcomes  
 70 the Africover Project as one of its newest Endorsed  
 71 Projects. The Focus 1 Office, in concert with FAO, is  
 72 planning the next phase of development, with a specific  
 73 focus on land-use attributes, and would like to hear  
 74 from land-use researchers and analysts interested in  
 75 participating in this ongoing effort.