Written Public Comments on the *Strategic Plan for the U.S. Climate Change Science Program*
Chapter 8: Land Use/Land Cover Change (pp 90-99)
Comments Submitted 11 November 2002 through 18 January 2003
Collation dated 21 January 2003

Page 90, Chapter 8: First Overview Comment: The term uncertainty is utilized without any clear definition of the term. As this is the main theme of much of the report, it portrays an incorrect image of climate science that everything is uncertain and that no one can or should act until the uncertainty levels are diminished. It then goes on to lay out a high risk strategy of waiting until an unknown day for uncertainties to be reduced before any action can be taken. The risks are high as the lifetime of greenhouse gases in the atmosphere is long and mitigation efforts will not take immediate effect, unlike some other pollutants. This also ignores decades of research by US institutions and others that have reduced uncertainty levels on a wide range of climate issues. A guide to the uncertainty levels is clearly included in the IPCC's Third Assessment Report.

We would therefore strongly recommend that the report and the research efforts around it not revolve around reducing uncertainties per se, but rather provide new and useful information for policymakers. Finally, to infer that policymakers must have 100% certainty before taking any decisions is not consistent with the current situation. As the report notes, there are many uncertainties surrounding terrorism, but the government is not waiting for 100% certainty before taking preventative measures such as increasing security in airports.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 90, Chapter 8: #1) There is a need to emphasize the impact of land use/land cover change on soil quality, soil resilience, elemental cycling and greenhouse gas fluxes.

#2) Which soil, hydrological, vegetational and microclimate processes influence local, regional and global environment.

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 90, Chapter 8: The following comments are directed to issues relating to land-atmosphere interactions. While these issues are relevant to many of the chapters in the CCSP draft, they are particularly motivated by text in the Water Cycle (7) and Land Use (8) chapters. Overview comments include:

• The CCSP draft correctly infers that the term ”global change” incorporates a change in the frequency distributions of important climate variables. This is more than a change in the mean values. Changes in the frequencies of occurrence of relatively rare, but extreme events, can have very large human implications.

• Consistent with frequency distribution concepts, the scientific output expected from CCSP projects should be amenable to coupling with proven risk management techniques.

• The CCSP draft uses the term ”watershed-scale” without su_cient background. Watersheds can span scales from the hill slope to continental. This raises issues of scale interaction models that are amenable to probabilistic modelling methods discussed elsewhere in these comments.

• A distinction between ”observations” and ”monitoring” should be made more clear in the CCSP draft. The science of global change research requires long-term observations of su_cient precision to permit discovery, quantify process, and support model building. Monitoring comes about after relevant thresholds have been established based on integrations of the science. The monitoring process is used to determine when thresholds are exceeded and remediation is required.

• Regarding observations, the CCSP draft is commendable in recognizing the need for ”coordinated data sets” and datasets from ”regional test beds”. These data entities will require substantial new support for infrastructure, personnel, and instrumentation.

• The interdisciplinary nature of the climate change problem is also recognized in the CCSP draft. What is perhaps not specified is a need to educate di_erently, at the graduate student level, to support CCSP needs. An educational goal is the development of a pool of multi-disciplinary climate change scientists capable of providing syntheses of science results necessary to interface with policy-makers. Also, the numbers of field scientists in training should be examined. A significant fraction of the pool of experienced field experimentalists is nearing retirement. Are their su_cient numbers of appropriately trained young scientists to replace them?

• The balance between observational and modelling emphases in the CCSP seems correct. We note a need for observational datasets su_cient to properly initialize and test mesoscale boundary-layer models and/or boundary-layer components in large-scale models. Such observations should span time periods commensurate with growing cycles in major biomes of specific continents, and eventually the globe.

• CCSP should consider a coordinated network of natural laboratories (an enhancement of the test bed concept in the CCSP draft). For water-cycle and land-atmosphere interaction issues, this coordinated network could consist of nested watersheds of various scales across the major biomes of the US, and eventually the globe. Land-atmosphere interaction research in support of climate change science naturally begins at a minimum resolved watershed scale. As a prototype example, we refer to the Cooperative Atmosphere-Surface Exchanges Study (CASES) that documents land-atmosphere interaction over a 5400 km2 watershed in a grassland biome of the Midwest. In a larger-scale context, we refer the CCSP authors to the Water, Earth, Biota (WEB) white paper that emerged from the Geosciences 2000 e_ort at NSF.

• Natural laboratory creation and maintenance will require substantial resources in time and dollars. The time horizons projected in the CCSP draft for many of the water cycle and land use science deliverables (typically 2 to 4 years), are unrealistically short. Ten year time horizons are more realistic. For example, the data-gathering component of a hydrology program in the CASES study area is 3 to 5 years, with 3 to 5 additional years (partly overlapping) planned for data analyses. The plans for CASES extensions also provide examples of the dollar investments to be required. The e_ort to generate from the CASES observations su_cient datasets for the initialization and validation of atmospheric boundary-layer models will require long-term sta_ng of O(10) technician and field scientist positions. A substantial instrument maintenance budget is also required over the decade long time period. We note that the resource requirement bounds outlined here are for a single natural laboratory.

• The CCSP draft correctly notes that there exists a geophysical component of waterborne (e.g. coastal inundation) and airborne (e.g. dust transport) disease processes. Understanding the relevant geophysics for such processes should be given a higher priority in CCSP.

References

for information regarding CASES see: http://www.joss.ucar.edu/cases.
for information regarding WEB see: http://cires.colorado.edu/hydrology

NorthWest Research Associates (NWRA), Dr. Robert Grossman

Page 90, Chapter 8: An additional question that should be posed here regards the impact of climate variability on land use and cover change (especially in vulnerable regions of the world, where changes have impacts that go beyond national borders). Climate variability issues/opportunities can be further developed throughout this section, especially to inform validation and valuation of land, land use, and land cover changes.

IRI, ZEBIAK AND STAFF

Page 90, Chapter 8: Overview Comment 1: More emphasis needs to be placed on the need for understanding at the local and regional scale of land use and land management and its impacts. The local and regional levels of land use and management are where the greatest changes might occur. That scale of understanding should be the basis of modeling efforts are well.

Overview Comment 2: Improved understanding in needed on the feedbacks between ecological, social, economic, health and climate controls and constraints on changes to the land. Feedbacks can have such important implications that they definitely need to be called out.

Overview Comment 3: The challenges in modeling these systems have been set forth and need to be included into this document (instead of just vague statements that the questions needs to be set forth). The vagueness implies that the scientific community knows little about how to model these processes.

Overview Comment 4: It is important that the topics of land use and land management are given this high level of treatment in this document. The existing chapter is a major step toward addressing these issues.

Overview Comment 5: I am concerned that urban land uses are given so much attention when other land uses (and their management and changes) have important implications as well.

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 90, Chapter 8: It would be a missed opportunity to use existing databases on land use that could be refined to aid in the climate science program. One obvious example is the databases maintained by the USDA-NRCS that could be adapted to the climate science program. The NRCS Natural Resource Inventory (NRI) could be refined to document agricultural land use with soil carbon change. As a result the NRI would be a more valuable resource which would make better use of public dollars. This could be done with partnerships with land-grant universities, NRCS and ARS.

CHUCK RICE, KANSAS STATE UNIVERSITY

Page 90, Chapter 8: OVC 1. How land use and cover interact spatially is a critical consideration in defining the interaction with the climate system and to society. Explicit consideration of the spatial patterning of land use and cover needs to be incorporated in Chapter 8.

OVC 2: It is not often clear that settlement patterns (e.g., urban and ex-urban developments) are being considered in the land use and cover considerations. Explicitly stating what range of land use and cover are needed to evaluate land surface feedbacks to the climate system. The role human-dominated land use and land cover types (e.g., urban, croplands, etc), as well as, more natural ecosystems (preserves, forests, etc) have a differential impact on the feedback to the climate.

OVC 3: Question 2: Land use intensity is a critical characteristic in describing land use and cover types. The feedbacks and interactions are often determined more by the intensity land is used and the nature which natural resources and other inputs are augmented by human activities related to a particular land use that affects the strength of the feedback to climate and other environmental considerations.

OVC 4: Question 4: Land management practices and associated resource use needs to be quantified explicitly to develop realistic and meaningful projections of land use and cover. The exchange of energy, water, and other biogeochemical compounds are responding to a particular land use management practice associated with water use, nitrogen inputs, organic matter management, etc.

DR. DENNIS OJIMA, COLORADO STATE UNIVERSITY

Page 90, Chapter 8: Focus is on Land use/cover change (use of remote sensing) no clear link is made to the need for resource maps of soils and geology and how soils maps can be used to predict land use and land use change. The focus is on remote sensing and below ground “stuff” soil is hard to look at with remote sensing yet the soil is often the driving force in land use and land use change and even land cover if that term is used.

SOIL SCIENCE, GLASENER

Page 90, Chapter 8:
POTENTIAL ROLE OF THE PARK SERVICE: The NPS is a steward for some of the most pristine land in United States territory, where anthropogenic influence (e.g., land-use, Chapter 8) is minimal. Data (e.g., the IMPROVE [Interagency Monitoring of Protected Visual Environments] and Inventory and Monitoring programs) is collected routinely in these areas. With CCSP guidance and a minimum of funding (taking advantage of infrastructure and personnel already in place), the NPS could provide a standardized, national-scale database, developed from core monitoring procedures and a core set of variables, that can answer the pressing climate change questions. Reviewer's

Comments on Chapter 8

Name, affiliation: Leland Tarnay, Ph.D., National Park Service-Center for Urban Ecology

The plan places much emphasis on the need to develop data for the period of 10 to 50 years into the future. This should be scaled back. We doubt that projections that extend to 50 years will have any accuracy, and they will have little value to decision makers. Emphasis should be placed on a shorter timeframe such as 3 to 20 years. Three years is suggested because it matches the federal budget cycle. Twenty years is suggested because it exceeds the life of most land use management plans and many private investments. We have a far greater need to know what will happen in five years than what might happen in 50 years.

The authors dwell on using history as an indicator of the future, but fail to mention the very specific situations where climate change caused land use changes. We should look specifically at these situations. A prime example is the changes in agriculture in the short to mid grass regions when the wet years early in the 20th century were followed by the dry years of the Dust Bowl. Current changes in the Sahel (the southern margin of the Sahara Desert) may provide another well documented example, although the cause and effect relationships are not as clear in the Sahel as in the Dust Bowl.

Having said that, it seems that the historic relationship between climate and land use may not be a good indicator of the future. As the nation and world move from an agricultural economy to an industrial economy to an information economy, climate becomes less important. When USA was a pioneering economy, population distribution was based on resources and climate. Now that we are a mature economy, population distribution is largely set in place by the investment in infrastructure.

In the face of climate change, forest and range-lands will remain relatively stable while agricultural lands, and possibly wetlands, will change rapidly. Agriculture occupies a huge land base and it is a huge industry, so it should be the major focus of studies of land use change. Impacts on agriculture can be predicted on the basis of agronomic and economic information, not historic relationships.

Major attention has been focused on sea level changes, and that is appropriate. We also need to pay special attention to the other extreme, i.e., the mountaintops. In North America, with mountain chains that run north and south, the southern mountains are "islands in the sky" with Arctic and sub-Arctic environments. As the climate warms and cools, low elevation species can redistribute themselves north and south, respectively. Species confined to the mountaintops cannot do this, so they are especially vulnerable and they should be given special attention.

Among most categories of species, there will be winners and losers as the climate changes. Most will not require management attention; those at the extremes may require management attention. Among the rare species, those that turn out to be losers may be pushed to the brink of extinction. Among the pest species, those that are too numerous, the ones that turn out to be winners will become even worse pests. An example might be mosquitoes and their associated diseases. Monitoring, research and management should be focused at these extremes.

Maybe there is a principle here ? we need to focus on the extremes. Reviewer's Name, affiliation: Dr. Terry Cacek, National Park Service-Biological Resource Management Division

NATIONAL PARK SERVICE

Page 90, Chapter 8: This chapter benefits from a competent and well-positioned team of experts long involved in land use and cover change research in the US and abroad (page 174). The topic (LUCC) calls for close linkages to all other chapters in the plan (what I refer here as 'integrated science', still these linkages are not explored (beyond mentioning chapter numbers) and explicitly articulated within each questions and research needs.

-While well-written, the chapter seems to mirror the plan as a whole as it reiterates research trends/questions already in place while missing the opportunity to stress the need for more 'integrated science'. More attention was also needed to 'human dimension' aspects of land use and cover change, such as on issues related to land use economics and agricultural markets, land use decision-making, policy and institutions, and demographic dynamics at various scales. These topics exemplify areas of great "uncertainty" in LUCC. The sections on "State of Knowledge" (after each of the 5 questions) basically reinstate points already mentioned during the introduction (plan and chapter) and are mostly too general to provide specific directions for future research needs.

- Some of the important topics on land use and cover change research that could have been incorporated or further explored while providing an "integrated science" approach to the plan include:

-*Land use - Water interactions*: land use systems, nutrient dynamics, hydrological cycles, Carbon cycle.

-*Land use - Atmosphere*: land cover change and rainfall patterns, farmers' response (land use decision making) to climate events, land use systems and greenhouse gases emissions.

-*Market incentives and land use*: credit and subsidies influencing large scale land use patterns, medium-term scenarios of land use in response to shifts in agricultural subsidies; shifting in global market demands and land use change.

-*Urban-growth and rural land use change*: urban spawn and land cover fragmentation, climate change -land value-agricultural change.

-*Land use – biodiversity*: patterns of land use change, habitat fragmentation; land use systems and adaptation of crop varieties to climate change

-Other areas requiring advances in LUCC research, and mentioned in the chapter, refer to methodological developments on the integration between social/economic/demographic data (field surveys and census data) and regional land use and cover spatial data. Examples a)Use of historical census data; b)Use of historical economic data (crop markets, land price, etc..); c)Ethnographic data on agricultural decision making, farmer's perception of climate change, institutions and social organization.

–The need for institutional cooperation and funding mechanisms to facilitate 'integrated approaches' has been recognized by national and international programs involved in global change research (NRC 1999, 2000, several IGBP-HDP science plans 1990-2002). More attention to these issues in the current plan would help to diminish 'uncertainties' and foster scientific advances relevant to policies for a changing world.

EDUARDO S. BRONDIZIO, INDIANA UNIVERSITY

Page 90, Chapter 8: This chapter seems well conceived and organized. The importance of land use and cover is suitably recognized and explained. However, this chapter seems to weigh heavily the importance of understanding past land use change as a predictor for future changes. A key missing component from this "equation" is "ecosystem function" as a driver for future changes – something poorly understood and/or of limited importance in the past. Past changes were largely influenced by resource proximity – understanding "resource" in this statement could range from economic "resource" return on investment to water availability for irrigation (and all possibilities in-between). Existing large data bases, for example soils inventories and recognized best uses of different soils, now allows land use decisions to be made based on function of this resource as they interact with intended uses. As a society that recognizes potential impacts of land use change, increased emphasis may be placed on "function" rather than "proximity".

SOIL SCIENCE, CRUSE

Page 90, Chapter 8: The issues of land cover change (Chapter 8), the carbon cycle (Chapter 9), and ecosystems (Chapter 10) overlap extensively. In order to closely link the research strategies for these three areas, the three chapters should explicitly reference each other at key overlapping points, as the IPCC authors did for the Third Assessment Report.

PATRICK GONZALEZ, THE NATURE CONSERVANCY

Page 90, Chapter 8: This chapter successfully establishes the significance of land use as a topic for research on climate change. However, this topic would be strengthened by expanding to add a focus on transportation. This would consider the interrelationships between land use and transportation, and the resultant impacts on GHG emissions. Land use is determined by public and private sector decisions on how to distribute commercial and residential activities, which influence travel patterns and the significant GHG emissions from the transportation sector. And in turn, transportation systems influence land use.

Research directed at better understanding these complex relationships would have a significant promise for improving the ability to consider the critical climate change implications of land use and transportation decisions.

Transportation, as much as any other factor, shapes development patterns and impacts the natural environment either positively or negatively. Land use and transportation are symbiotic: how development is spaced can greatly influence regional travel patterns, and, in turn, the degree of access provided by the transportation system influences land use distribution. [1]

The location of economic functions and housing greatly influences travel patterns, distances traveled, transportation modes used, and congestion. This distribution of land use and the impact that it has on the transportation system is often the cause of congestion that contributes to air quality that is unacceptable for healthy living. Transportation is not mentioned in this chapter even though it often acts as a guiding force for new development.

DEPARTMENT OF TRANSPORTATION, LAWSON

Page 90, Chapter 8: Overview Comments on Chapters 8, 9, and 10
Integrate chapters: These three chapters should be merged into a single chapter that addresses land use/cover, ecosystems, and the terrestrial component of the carbon cycle. The marine component of the carbon cycle and comprehensive carbon cycle modeling could be addressed in a separate chapter or in the chapter on atmospheric composition. Integrating the chapters focused on the terrestrial biosphere would reduce redundancy in the exposition, and more importantly, reduce the risk of analytical inconsistencies. For example, terrestrial carbon cycle models often project a terrestrial CO_2 sink without considering changes in land use that could eliminate the forests assumed to be sequestering carbon in response to higher CO_2 concentrations. Integration of the chapters will also help to focus attention on the key interactions and feedbacks between climate change and terrestrial ecosystems, including albedo as well as carbon cycle changes.

Focus on overriding issues: The draft plan lacks focus and fails to set priorities. Priorities should be based on relevance to refining our understanding of what is required to stabilize heat-trapping greenhouse gases in the atmosphere at a level that prevents dangerous human interference with the climate system. Key issues to highlight are:

- What carbon budget is compatible with different stabilization levels given feedbacks?
  - Ocean CO_2 uptake
  - Climate change and CO_2 fertilization impact on NEP
  - Changes in forest cover impact on albedo
  - Climate change impacts on methane emissions
- How can inventory and inverse estimates of the North American sink be reconciled?
- How can carbon stock changes due to management practices be distinguished from changes due to other factors?
  - CO_2 fertilization, nitrogen deposition
  - Climate variability, climate change
- How will ecosystem services be affected by global change?

DANIEL LASHOF, NRDC

[1] The Metropolitan Transportation Planning Process: Key Issues, Nov. 2001

Comments on Chapter 8

Page 90, Chapter 8: I found this chapter to be weak relative to the other GCRP chapters. The payoffs were exclusively maps, databases, and reports. There were few identified improvements in science (i.e. what answers will be provided?) I recognize that that Land Use is a complex topic, but this chapter does not make a compelling case for investment.

MARK R. ABBOTT, OREGON STATE UNIVERSITY

Page 90, Chapter 8: While the chapter does a good job of covering issues dealing with major changes in land use/land cover such as conversion of forests and agricultural land to urban use, etc., it does not adequately address the effects of management decisions on land use. For example, within agricultural lands, the balance between greenhouse gas sources and sinks will be greatly influenced by such things as annual vs. perennial cropping systems and conventional vs. no-till practices. In forests, the ability of young, rapidly growing stands to sequester carbon could be quite different from that of mature, old-growth stands which could actually be carbon sources. These subtle differences within major land use groups needs to be more adequately addressed. Some of these issues are covered in the carbon cycle chapter suggesting the better linkages among chapters is warranted.

R. HOWARD SKINNER, USDA-ARS

Page 90, Chapter 8: The importance of this issue is underscored by the recent paper by Pielke et al. *(Phil. Trans. R. Soc. Lond*. Vol. 360, pp. 1705 – 1719, 2002). This deserves priority attention.

GEORGE WOLFF, PH.D., GENERAL MOTORS

Page 90, Chapter 8: Shorelines

A large portion of the population now lives in coastal areas, and the rate of population growth in these areas is higher than the average (Cohen et al., 1997). A change in sea-level in these areas would have a huge impact on both the economy and wellbeing of the region. The CCSP strategic plan would be deficient by not including activities to measure and monitor shoreline change and their impacts.

The shore zones of the world are both potent indicators and potential controllers of global climate change. Defined in name and geography by the shoreline, the interface between land and water, these regions occupy one of the most dynamic, diverse, and productive areas on the planet. These regions are densely populated, highly bioproductive, and exquisitely sensitive to climate change. That sensitivity is manifested in both biophysical impacts and socioeconomic impacts, primarily in terms of eustatic change in sea level, but secondarily in terms of environmental and ecosystems shifts that accompany changes in shoreline that may be amplified by isostatic responses or exacerbated by subsurface fluid withdrawal. Shoreline is then a powerful agent in measuring, understanding, and predicting climate change. Shoreline change will significantly alter regional albedo, bioproductivity (consequently carbon fixation), and coastal circulation patterns. These effects feed back into changing the climate.

Shoreline change likewise poses an immense impact on society, since the vast majority of the nation's and world's population occupy the shore zones. Any change immediately and drastically effects population whether the shoreline advances, forcing people to retreat or drown, or whether the shoreline retreats, offering up new, albeit low-lying and risk-prone land for development. Current examples of shoreline-societal crises are New Orleans, awaiting a killer hurricane, Long Beach, diking and abandoning land to petroleum production, Venice, Italy continuing to fight a losing battle against a rising sea, or the periodic tragedies of Bay of Bengal hurricanes striking the Bangladeshi coast with horrific loss of life.

There have been several studies over the last decade (e.g. Timmerman et al., 1999; Nicholls et al., 1999; and Dean, 1990) to document and predict the impacts of climate change and sea-level rise on coastal systems. The implication of a change in sea-level due to a change in climatic conditions (i.e. global warming) is that there will be tendencies for eroding shorelines to erode further, stable shorelines to begin to erode, and accreting shorelines to wane or stabilize (Bird, 1993). Such changes to the coastal environment will result in increased loss of property and habitats, higher storm-surge flooding, inhibition of primary production processes, and loss of tourism, recreation, and transportation functions.

Shorelines and shoreline change are critical indicators and controllers of climate change.

Bird, E.C.F., 1993. Submerging Coasts: The Effects of a Rising Sea Level on Coastal Environments. John Wiley and Sons, Chichester, United Kingdom, 184 pp.

Cohen, J.E., C. Small, A. Mellinger, J. Gallup, and J. Sachs, 1997. Estimates of coastal populations. Science: 278, 1211-1212.

Dean, R.G., 1990. Beach response to sea level change. In: The Sea [le Méhauté, B. and D.M. Hanes (eds.)]. John Wiley and Sons, New York, USA, 9: 869-887.

Nicholls, R.J., F.M.J. Hoozemans, and M. Marchand, 1999. Increasing flood risk and wetland losses due to sea-level rise: regional and global analyses. Global Environmental Change, 9: S69-S87.

Timmermann, A., J. Oberhuber, A. Bacher, M. Esch, M. Latif, and E. Roeckner, 1999. Increased El Niño frequency in a climate model forced by future greenhouse warming. Nature, 398: 694-696.

NOAA-NESDIS – DIVINS

Page 90, Chapter 8: Characterization and monitoring of the global land surface is crucial to understanding climate change and the impacts of climate change on human and natural systems. Changes in land cover can alter albedo, transpiration, carbon balance, and surface temperature. When land cover change expands to regional scale the overall effects on the local to regional climate can be significant.

The primary agent of land cover change is our species. The continued expansion of human population numbers and living standards produces a persistent pressure for land cover changes, such as deforestation. Cumulatively this land cover change will have a dramatic impact on biodiversity, air, food, and water supplies during the coming decades. In many parts of the world rates of land cover change and land degradation are not sustainable, raising questions on how to redesign the human enterprise.

The feedback processes between land cover change and global climate are not well defined. To address this climate models would need to incorporate representations of the biophysical characteristics of the land surface and to compare climate outcomes under varying scenarios of land cover change.

The chapter outlines a research program designed to produce land surface products and predicted land cover changes suitable for use in the study of land surface / climate interactions, the carbon cycle, and ecosystems. Global mapping of human settlement and monitoring of biomass burning could be used to build gridded carbon and aerosol emission databases, which are called for in atmospheric composition studies (Chapter 5).

The satellite observations required for global mapping, characterization and monitoring of the land surface during the next 10-20 years have been planned for and are under development (e.g. EOS => NPP => NPOESS). Compared to the cost of planning, building, launching and operating these systems, the level of investment to make and provide access to the scientific products to support the CCSP is very modest. Chapters like this point out the value of using operational satellite observations to address important science and policy issues.

NOAA-NESDIS, ELVIDGE

Page 90, Chapter 8, There should be close linkage between the activities in Chapter 8 (which emphasizes data and mapping) and Chapter 11 (which could provide more insight about the behavioral theories behind changes in land use and land cover). Question 4 in Chapter 8 is crucial.

ANN FISHER, PENN STATE UNIVERSITY

Page 90, Chapter 8: The most disappointing thing about this chapter is its apparent lack of a conceptual theory or even a unifying vision for approaching the topic. It calls for extensive empirical observations and cataloging without providing a framework for thinking about or organizing land use and land cover change knowledge. It offers no reason even why land cover and land use (two different things) should be united as the same activity or why investigating their change is a “science”. Unlike the chapters on ecosystems, the carbon cycle, and human interactions, this chapter is peculiarly free of a unifying vision other than the obvious fact that land covers and land uses are discrete elements of landscapes reflecting physical, biological, and social processes.

Second Overview Comment: It would be disingenuous to criticize the authors for a lack of vision without at least offering a possible candidate alternative. If there is a unifying theory of land use/land cover change, I suspect it involves the relentless urbanization of societies and landscapes over history and the ways that energy gets captured and concentrated by urbanization processes. (The word “energy” is mentioned only twice in this chapter.) This vision sees rural landscapes as the suppliers of energy (food, fuel, and fiber) and the urbanizing landscapes as consumers (and drivers of change). It would chronicle the rapid growth and urbanization of the world's human population as a function of energy technologies. This approach suggests landscape patterning and organization – land use/land cover change – as an outcome of energy consuming processes and a way to account for its potentially harmful byproducts (CO_2, methane, etc.) in the environment.

TOM WAGNER, UNIVERSITY OF MICHIGAN

Page 90, Chapter 8: Overview Comments
The focus on land use change as a dynamic (both contributor to and consequence of) climate change factor is important and useful. However, the 5 Questions in Chapter 8 appear to overlook the reality that large-scale land cover changes driven by climate change are already well under way, especially in Alaska where there is very little direct human land modification. Some of these climate/land cover changes include tall shrub expansion and invasion of tundra, deglaciation and revegetation of land surfaces, shrinking lakes and wetlands, widespread loss of conifer cover from insect outbreaks, and potential forest invasion of tundra. Most of these climate-related natural land cover changes have considerable climate feedback effect. We suggest that climate sensitive <u>processes</u> and <u>effects</u> of natural land cover change be recognized as an important research need.

WELLER, ET AL, UNIVERSITY OF ALASKA FAIRBANKS

Page 90, Chapter 8: In this context we feel that it will be useful to define whether the research will look at purely US-impacts, or effects on other countries s well. As many commodities are internationally traded, there could be secondary effects on US agriculture and land-use, for example, as a result of changes in agricultural production elsewhere in the world. This consideration applies to the topics in Chapter 8 but also to the socio-economic scenarios in Chapter 4.

WARRILOW, WILKINS – UK DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS

Page 90, Chapter 8: First Overview Comment: The chapter in general does not appear to recognize the current level of effort mounted by local and state governments, and occasionally regional consortia. The major questions and many of the products and payoffs listed under each question are well posed and welcome but the entire description of the issue could be considerably enhanced through collaboration with states and regions.

CALIFORNIA RESOURCES AGENCY

Second Overview Comment: This section emphasizes prospective research on future land modification, but there is much to be learned from assessing the effects of past landscape-scale land modification. This involves two basic research areas:

1) Past land cover reconstruction in populated areas. This is currently a "cottage industry" within academic circles, but it needs far more support. Much of the work done to date is anecdotal, and some is colored by methodological bias;

interpretation of past changes (e.g. the deforestation of Europe and its subsequent afforestation, the conversion of the central U.S. from grassland to farms) will be most instructive when there is accurate data on what the past land cover was, and how past ecosystems functioned.

2) Land cover change is not only a product of direct human disturbance and modification, but may arise as a consequence of climate change. The effects of changing seasonality of precipitation, temperature regimes, or disruption of hydrologic processes (e.g. the loss of perched soil water when permafrost melts) may have important effects on carbon uptake, biogenic emissions, dust, or other direct effects on the atmosphere in addition to potential changes in surface albedo.

-CALIFORNIA AIR RESOURCES BOARD

Page 90, Chapter 8: Prioritize Question 5 on the combined effects of and feedback between climate and land use/cover change. Questions 1 through 4 address land use/cover change without overt reference to the climate change context. Such models and research to project future changes in land use and cover may be irrelevant if they do not consider land usages undertaken for adaptation and mitigation purposes.

More particularly:

- Address in a more integrated manner the relation between land use/cover change, ecosystems and potential mitigation/adaptation measures.
- Assess the effects of particular land use practices for climate change (e.g., urban growth, agricultural expansion, conservation, sequestration efforts) considering issues of population growth and increased demands on resources (e.g., ecosystem services).
- Assess relevant mitigation and adaptation measures considering issues, such as market/non-market costs, feasibility, unintended consequences, timeframes, and efficacy for achieving stabilization and human/wildlife welfare goals.
- Build on pre-existing work, particularly the National Assessment of Climate Change Impacts on the United States.

BURGIEL, DEFENDERS OF WILDLIFE

Page 90, Chapter 8: This the a good and timely chapter. As one panelist said, there is no denying that land use/land cover has become a "stand-alone issue." One key problem I perceive with the chapter is that it gives the impression that we know less about this topic than we actually do. There is already some understanding related to some of the questions being posed. Examples follow:

"What are the primary drivers of land use and land-cover change" (p.90). See McDaniel, N., and D.N. Borton. 2002. Increased human energy use causes biological diversity loss and undermines prospects for sustainability. BioScience 52(10): 929-936; Czech, B., P.R. Krausman, and P.N. Devers. 2000. Economic associations among causes of species endangerment in the United States. BioScience 50 (7): 593-601; Sisk, T.D., A.E. Launer, K.R. Switky, and P.R. Ehrlich. 1994. Identifying extinction threats. BioScience 44(9): 592-604.

Comments on Chapter 8

"What tools or methods are needed to allow for better characterization of historic and current land use cover characteristics and dynamics" (p.90). See O' Neill, R.V., et al. 1997. Monitoring environmental quality at the landscape scale. BioScience 47 (8): 513-519.

"What are the combined effects of climate and land use and land cover change and what are the potential feedbacks" (p. 90).
See Dale, V., et al. 2001. Climate change and forest disturbances. BioScience 51 (9): 723-734; Aber, J., et al. 2001. Forest processes and global environmental change: predicting the effects of individual and multiple stressors. BioScience 51(9): 753-754.

SHAFER, NATIONAL PARK SERVICE

Page 90, Chapter 8: After reading the draft strategic plan, some readers might presume that any potential mitigation action must await more precise knowledge. And there is no denying the fact that more knowledge is needed and that predictions preferably need to be available with better levels of confidence. But this argument can always be made at any stage in the evolution of a field of knowledge. Knowledge is always imperfect; confidence levels can always be improved, and on. As one panelist for Chapter 4 said, "All decisions are made under uncertainty." And she stressed that we should ask "what is the least amount of information needed to make a decision." If present knowledge is any predictor, if our society waits another 20 years to refine a mitigation strategy, much loss will be irreversible. If refining our knowledge through research becomes an unconscious method of stasis, then science will benefit but society as a whole may not. So synthesis of what we already know is a crucial need. This chapter might incorporate synthesis as a major thrust, with a completion time line of "very soon." This point blends into comments offered on another chapter.

CRAIG SHAFER, NATIONAL PARK SERVICE

Page 90, Chapter 8: 1. In this chapter specifically, and throughout the plan as the individual chapters like the water cycle and the carbon cycle link and crosscut with this chapter there is a need to establish a common framework for discussion of land use change scenarios. I would propose that this Science Plan take on the ambitious objective of developing a suite of land use change outcomes or conditions for 2100 AD. This effort would obviously parallel the work of the IPCC on the identification of emission scenarios. I envision a formal process whereby one of the critical products of this plan is to develop scientifically defensible land use change scenarios based on the very best estimates for the ranges in likely future population growth and economic development and integrated with thew very best estimates of ranges of climate change . . . taking into account that warming without increases in precipitation will likely necessitate the "extensification of agriculture" i.e. the conversion of more grassland, forest landand shrub land into more intensive agricultural production. The adoption of a suite of land use change scenarios would provide a framework for future analyses on how such changes in land use would interact with the carbon and water cycles. This framework would allow for more productive model intercomparisons. One of the criticisms of this chapter that I have is that there is such an infinite set of possible outcomes for combinations of land use/water cycle and carbon cycle changes that it is difficult to focus on any specific set of combinations that cover a range of tractable issues.

THOMAS G. HUNTINGTON, U.S. GEOLOGICAL SURVEY

Page 90, Chapter 8: While the chapter does a good job of covering issues dealing with major changes in land use/land cover such as conversion of forests and agricultural land to urban use, etc., it does not adequately address the effects of management decisions on land use. For example, within agricultural lands, the balance between greenhouse gas sources and sinks will be greatly influenced by such things as annual vs. perennial cropping systems and conventional vs. no-till practices. In forests, the ability of young, rapidly growing stands to sequester carbon could be quite different from that of mature, old-growth stands which could actually be carbon sources. These subtle differences within major land use groups needs to be more adequately addressed. Some of these issues are covered in the carbon cycle chapter suggesting the better linkages among chapters is warranted.

STEVEN R. SHAFER, USDA-ARS

Page 90, Chapter 8: First Overview Comment: The plan addresses the interaction between land use/land cover change, climate change, water cycle and carbon cycle. Although the plan talks about coupled climate-land use change models, significant understanding of this interaction could be gained by incorporating land use change data into coupled climate and *carbon cycle* models.

Second Overview Comment: In order to improve our understanding of the interaction between land use change and climate change on local, regional scales, significant effort should be devoted to high-resolution modeling of climate. The projected land use change data should be incorporated into these models to project the future impact of land use/land use cover changes.

Third Overview Comment: Granted that the subject of the chapter is land use/land cover change, a significant effort should be devoted to understanding the impact of the future land use changes on the carbon budget of the Earth system. Focus on such interaction will add value to the various methods of carbon sequestration projects.

BALA GOVINDASAMY, LAWRENCE LIVERMORE NATIONAL LABORATORY

Page 90 and 92, Question 2 – deals only with data (note that models are another type of tool); so change question to be "What **data and methods of data collection and analysis** are needed …."

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 90, line 3: One of the really important emerging issues that seems to be totally neglected here is what effect past changes in land cover (going back hundreds to 1000 years or more) may have done to the climate. There have likely been regional and even global influences, on temperature, precipitation, and, speculating a bit, sea level. Provision needs to be added to cover this issue given this is a long-term plan.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 90, Line 5: "Land use and land cover change is perhaps the most prominent form" - How is this evaluated? What metric is used?

RONALD STOUFFER, GFDL/NOAA

Page 90, Line 8: While much of the activity of this chapter could shed light on the impact of urban heat islands on the surface temperature record, this element of research should be much more explicit, and a key focus of the chapter.

KENNETH GREEN, FRASER INSTITUTE

Page 90, line 8: Following the word "ways," please add the sentence "Predominant effects are on soil quality and cycling of principal elements such ad C, N and H2O."

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 90, line 14: Recommend adding transportation as an influence on land use patterns.

DEPARTMENT OF TRANSPORTATION, LAWSON

Page 91-92: The history of the land use/land cover work is unfortunately illustrative of the problems of trying to squeeze abstract comprehensiveness into a process that ends up looking like a model but is really a large checklist. The grand statements are academic, but the case specifics are the scene of the action and the source of real value. While the Clark University group diligently pursued the grand synthesis, doing as well as possible, the serious debate was over the soil fertility and carrying capacity arguments in Kenya inspired by claims of "more people, less erosion" by Mortimore and Tiffen, countering generalized statements to the contrary.

All of social science is relevant, but so what? For any given case and place, the question is not how anyone would look at it, but can anyone from any discipline or perspective persuade us that there is a policy prescription which works on points of leverage and helps solve problems. This is where the grand synthesis is background which cannot be applied without "marching right back" to the specifics of the case to see what happened and what to do about here and now. Knowing some huge set of historic drivers is marginal to acting usefully.

WIENER, INDIVIDUAL COMMENTATOR

Page 91, Line 1, remove “the geophysics of.”

BALA GOVINDASAMY, LAWRENCE LIVERMORE NATIONAL LABORATORY

Page 91, line 5: The fact that LUCC may also of itself impact on climate variability and change, particularly at the regional level also needs to be acknowledged.

JULIA SLINGO, NCAS/CGAM, UK

Page 91, Line 5: add: Developing this knowledge would entail instrumenting small watersheds to obtain watershed process data

Comments on Chapter 8

Bonta, USDA

Page 91, line 12-19 -- I recognize that the goal is to provide two overarching research questions (such as is done in the other chapters), but these questions are awkwardly worded and are clearly more than two questions. How about rephrasing the questions to be:

- **How can greater understanding of the influence of social, economic, and ecological processes on the temporal and spatial distributions of land-cover and land-use change improve projections of these changes?**
- **How may changes in land use, management, and cover affect environmental and socioeconomic conditions, including economic welfare and human health?**

I realize than some of the detail is not included in this phrasing, but it seems better to be understandable than to have all of the details.

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 91, second paragraph. Again this statement "…scientific underpinning for land use decision making…" is unclear. Most land use decisions are made today by the private sector, and without much understanding of long term repercussions to the environment or other better uses of the land. Will this scientific underpinning be of value to governmental bodies for policy on zoning? Will the better understanding be of value in the design of better uses of the land? How will this work?

SOIL SCIENCE, KISSEL

Page 91, line 18: Please add the sentence "What soil, vegetation and hydrologic processes influence the local, regional and global environment?"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 91, line 27 – "…the direct **and indirect** impacts of land use and land cover change" should be considered.

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 91, line 28: LUCC may also affect biogenic emissions and hence the atmospheric chemistry and composition.

Julia Slingo, NCAS/CGAM, UK

Page 91, lines 32-33 – The ability to forecast land use and land cover change and, ultimately, to predict the consequences of change, **depends** on …" <Note: this should not be future tense.>

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 91, line 33: **(37-S)** The usage in this sentence of "forecast" and "predict" cry out for "project", in the sense it's being used in this document.

HP HANSON. LANL

Comments on Chapter 8

Page 91, Lines 33-35: While it is important to understand the past, it is not always a good guide to the future. Increased globalization is likely to drive land use change in ways not easily predictable from past history. One could infer from language in several places in this chapter that globalization is a key driver but it deserves more explicit recognition.
California Resources Agency

Page 91, line 33: Change "predict" to "project" as they consequences are conditional on a lot of things.
Michael MacCracken, LLNL (retired)

Page 91, l 34 …will depend partially on our ability…
SOIL SCIENCE, CRUSE

Page 91, l 35 …change. Future land use changes may increasingly be made based on improved understanding of ecosystem function and the impact land use changes may have on selected environmental component(s). Historical…
SOIL SCIENCE, CRUSE

Page, 91, line 36 – should be "economic **development, transportation patterns**,..."
VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 91, line 37 – "environmental **forces** (..) and social **forces** (..)"
VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 91: Question 1, last paragraph on page 91. Patterns of human settlement in the US were shaped by soils and access to water transportation more than anything. Both **soils and water transportation** should be mentioned in this statement. Settlers were largely agrarian at the time of settlement of the US, and prosperous communities developed where crops grew well. Good soils promote high crop yields, which in turn promote prosperity and related business development. It is no accident that Dallas, Waco, Austin, Houston, and San Antonio in Texas are located on or just adjacent to deep prairie soils and not on the poor clay pan soils of that state. Also note that Memphis, Evansville, Louisville, Cincinnati, and St Louis are adjacent to highly productive agricultural areas (excellent soils) with excellent water transportation. Although railroads later made water transportation less important, at the time of settlement, good water transportation was dominant.
SOIL SCIENCE, KISSEL

Page 92, l 2 …factors, coupled with improved understanding of ecosystem function resulting from these changes, will improve
SOIL SCIENCE, CRUSE

Page 92, Line 7-17: Climate change due to past land use changes "may" be larger than the ones listed here. See PP97-98.
Ronald Stouffer, GFDL/NOAA

Comments on Chapter 8

Page 92, line 8 – "…trends that shaped **human** expansion…" <Note the concept of "land use expansion" makes no sense, even though certain types of land uses can expand.>

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 92, line 9 – **Historically,** why and how have land use and land management systems (e.g., agriculture) spread **and been constrained**?

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 92, Line 12: new bullet: How does climate change impact agricultural decisions such as crop/animal type, diseases, insects, etc. during a changing climate?

BONTA, USDA

Page 92, Line 16: Please add the sentence "How does the impact on soil quality and elemental cycling influence the future land use/land cover?"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 92, line 19: Broad land cover classes do not provide enough vegetation species information for understanding species-specific impacts or for properly calculating carbon sequestration and losses. Therefore, a fundamental research need is for plant species composition of land cover classes. This would require much more field work to ground-truth remote sensing data.

PATRICK GONZALEZ, THE NATURE CONSERVANCY

Page 92, l 20 …use, ecosystem function, and land cover…

SOIL SCIENCE, CRUSE

Page 92, Line 22, wording is awkward. Remove "change detection".

BALA GOVINDASAMY, LAWRENCE LIVERMORE NATIONAL LABORATORY

Page 92, line 23: Insert, "such as the impact that transportation systems have on land use" after "...influences another"

DEPARTMENT OF TRANSPORTATION, LAWSON

Page 92; line 28: … variability. Development of appropriate methodologies to better integrate information between the social and physical-environmental sciences will be needed to adequately address the interaction of human and environmental factors affecting agents of land use change. Consideration of how to integrate this information across appropriate time and space scales will take joint research engagement between the social and physical science community. …

DR. DENNIS OJIMA, COLORADO STATE UNIVERSITY

Page 92, Line 28: add: Furthermore, studies are needed to evaluate how climate change affects agricultural decisions and vice versa.

BONTA, USDA

Comments on Chapter 8

Page 92, lines 29-35: The timescales assigned to products and payoffs adds clarity. Recommend using a similar template throughout the document.

DEPARTMENT OF TRANSPORTATION, LAWSON

Page 92, lines 31-37: This all seems very ambitious—and will require a lot of resources. Promising it without the commitment of resources would seem to be little more than wishful thinking.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 92, line 31 – What does "<2 years" refer to? Is this the time period over which the work is expected to produce a payoff?

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 92, Line 38: Specific Comment [page 92, line 38]. Potential of hyper-spectral imaging for the detection of "characterization of current land use and land cover characteristics and dynamics"

OSMOND, COLUMBIA UNIVERSITY

Page 93 et seq.: I urge funding a small series of symposia with groups such as the American Society for Environmental History, which has a great deal to offer in providing case-study insights into what has happened. It would be very interesting to see how well their cases can be used as samples of different kinds or sequences of processes in land use/land cover change. There is no point in arguing over historiography; lets just get help in finding good work and using it.

WIENER, INDIVIDUAL COMMENTATOR

Page 93, line 2ff: This is really not a statement of the State of Knowledge, but of what the research will cover. A baseline for information (like the IPCC reports fro climate) needs to be given.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 93, Lines 7-14: The plan recognizes existing data sources (implicitly, state and sectoral programs) for land cover and land use, but fails to recognize the considerable problems in bring those irreplaceable (e.g. requiring hundreds of person years to produce) data sets into the analysis. These data sets are frequently non-digital and often use idiosyncratic classifications. The problems are large yet surmountable, but require resources and a focused outreach program to regional and state data stewards.

CALIFORNIA RESOURCES AGENCY

Page 93, line 8ff: this will require a great deal of analysis (and again, a lot of resources).

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 93; line 11: … statistics, settlement patterns, resource use, and …

DR. DENNIS OJIMA, COLORADO STATE UNIVERSITY

Comments on Chapter 8

Page 93, Line 17: "What are the current patterns and attributes of land use and land cover at national to global scales..." (p.93). See Heilman, G.H., et al. 2002. Forest fragmentation of the conterminous UnIted States: assessing forest intactness through road density and spatial characteristics. BioScience 52(5): 411-422; Olson, D.M. et al. 2001. Terrestrial ecoregions of the world: a new map of life on earth. BioScience 51 (11): 933-938; Sanderson, E.W., M. Jaiteh, M.A. Levy, K.H. Redford, A.V. Wannebo, and G. Woolmer. 2002. The human footprint and the last of the wild. BioScience 52(10): 891-904;

SHAFER, NATIONAL PARK SERVICE

Page 93, Line 17: new bullet: What is the best way to characterize and parameterize various land uses in watershed models for simulation purposes?

BONTA, USDA

Page 93, Line 20: "What are the national and global rates, patterns, and characteristics of contemporary land use and land cover change" (p. 93). The rates of change for some areas in the United States, such as conversion of natural or agricultural land to development, have been calculated. For example, see Wang, Y., and D.K. Moskovits. 2001. Tracking fragmentation of natural communities and changes in land cover: applications of Landsat data for conservation in an urban landscape (Chicago Wilderness). Conservation Biology 15 (4): 835-843.

SHAFER, NATIONAL PARK SERVICE

Page 93, line 22-23 – Insert question "**Under what ecological and socioeconomic conditions are large charges most prevalent?**"

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 93 lines 24-27, need to look at soils here

SOIL SCIENCE, GLASENER

Page 93, line 30, insert:
Statistics (e.g., census information), vegetation and materials reflectance and radiative properties, and remotely sensed measurements?

NIST, HRATCH SEMERJIAN

Page 93, line 31 add:
What are the most important climate-driven processes of natural land cover change and what are their feedback effects on climate change?

WELLER, ET AL, UNIVERSITY OF ALASKA FAIRBANKS

Page 93, line 31: Please add the sentence "How can the data credibility and reliability be verified?"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 93, Lines 38-40: As a user of USGS land use/land cover data, I assure CCSP that we need continued and considerable effort focused on accurate attribution of landscape characteristics. While this effort might be characterized as research, it truthfully involves more rigorous and regionally specific mapping, which once again can best be done via consortia with regional and state agencies.

CALIFORNIA RESOURCES AGENCY

Page 93, line 38 – replace "begin" with "**progress**."

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 93, line 40 – replace "will require a considerable research effort." with "**requires** considerable research **efforts**."

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 93; line 41: … needed. Development of land use management data associated with various land use and land cover types is critical to quantify the feedback to environmental and climatic changes.

DR. DENNIS OJIMA, COLORADO STATE UNIVERSITY

Page 94, l 1 …information. Improved models addressing ecosystem function on large scales will be critical. These models must be capable of integrating a broad range of site information increasingly available, and must be able to identify the environmental impact of changes brought about by land use alterations. Concurrently, these models should be capable of identifying the potential for the existing ecosystem to appropriately support proposed changes to the area under consideration. As…

SOIL SCIENCE, CRUSE

Page 94, line 4: **(38-E)** A verb problem: " A new suite...is needed."

HP HANSON, LANL

Page 94, lines 4- 17 (Products and Payoffs), need to like these items to the soil and soil maps.

SOIL SCIENCE, GLASENER

Page 94, line 5: **(39-S)** "Projections" is probably more appropriate here than "predictions".

HP HANSON, LANL

Page 94, Line 8: new bullet: Methods for characterizing and parameterizing land use, such as urban and agricultural uses, for watershed models to evaluate the effects of climate change.

BONTA, USDA

Page 94: between line 10-11: Quantification of land use management practices and resource utilization relative to processes controlling feedback to the climate and other environmental considerations.

DR. DENNIS OJIMA, COLORADO STATE UNIVERSITY

Comments on Chapter 8

Page 94, Lines 20-39 and Page 95, Lines 2-23: The issue of projecting land use and land cover change is clearly central to the scenarioing capacity emphasized elsewhere, yet the entire discussion of current capacity and future research in this area is overly general and does not reflect the state of the science, at least in California. Several researchers have been pursuing this topic for more than a decade, and have developed models of urban development and rural settlement, as well as agriculture in the Central Valley. The lack of specificity in the plan may result from a national perspective on what is fundamentally a state or regional issue. The CCSP will accelerate research in this area far more quickly by building partnerships with state and regional assessment and research efforts. Specifically, the CCSP must ensure that any national and global projection models are compared to state and regional models, lest they become too detached from reality.

CALIFORNIA RESOURCES AGENCY

Page 94, line 29 – replace "the regional" with "**local and** regional.." Delete "with this"

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 94, line 34-36 – Question is too vague; we need to list these questions arising from modeling efforts instead of asking what they are. Some questions are:

What spatial and temporal level of information and modeling are needed to project land use and land management and its impacts at regional, national, and global scales?

How and under what conditions are future responses to land use and land management expected to differ from past responses?

What are the major feedbacks between socioeconomic and ecological influences on changes in land use and land management?

What are the major patterns of changes in land use and land management occurring today?

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 94, lines 37-39: This is quite a challenging effort, and a need that the National Assessment efforts pointed out was needed. How might it even be approached?

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 94, line 37-39 --- This vague question can be reworded to read "**Given specific climate, demographic, and socioeconomic projections, what are the key sources of uncertainty and major sensitivities in projecting characteristics of land use and land cover change into the future for five years to five decades**?"

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 95: Continuing, these sequences and real cases are a sound basis for scenario construction and considerations, which should not be overlooked. The diversion of effort into some giant model view is insufficiently productive; we should not waste the humanities and history by disregarding their interpretations and methods.

WIENER, INDIVIDUAL COMMENTATOR

Page 95, line 3 – Delete "new"

Comments on Chapter 8

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page. 95, line 4 – "This **need** …"

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 95, Line 5: add after change: , characterization/parameterization of land use elements,

BONTA, USDA

Page. 95, line 6 – "**annual to** decadal time scales

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 95, Line 17: new bullet: Better parameterization methods for watershed models.
96:14 change rural to agricultural

Bonta, USDA

Page. 95, line 17 – Why is the focus only on urban growth models? Models are also needed for change in all other land cover types (especially suburban, x-urban, agriculture and forest lands

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 95, Line 18, time frame missing for this task.

BALA GOVINDASAMY, LAWRENCE LIVERMORE NATIONAL LABORATORY

Page 95, line 20 – Replace "national" with "national**, regional and local**" for models are needed at all levels-- especially, local and regional since land use change is largely a local phenomenon.

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page. 95, line 21-22 – Refer to model**s** instead of a single model.

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 95, line 27: Following the word "local" please add "soil and"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 95, lines31-33. Water cycle is greatly affected by the soils (all water moves through or over the soil) unless it falls on a water body. Need to address land management here

SOIL SCIENCE, GLASENER

Page 95, line 32: Following the word "characteristics" please add "soil properties"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 96, Line 14: "How will changes in urban and rural land use and land cover influence the spatial and temporal distribution of wildlife and what are the resulting economic, social, and ecological impacts" (p.96). See Hansen, A.J. et al. 2002. Ecological causes and consequences of demographic change in the New West. BioScience 52(2): 151-162; Irland, L.C. et al. 2002. Assessing socioeconomic impacts of climate change on US forests, wood-product markets, and forest recreation. BioScience 51 (9): 753-764; Losos, E. et al. 1995. Taxpayer-subsidized resource extraction harms species. BioScience 45(7): 446-455.

SHAFER, NATIONAL PARK SERVICE

Page 96, Line 17: after public add ìand privateî

BONTA, USDA

Page 96, line 17 – What is the “form” of public lands?

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 96, line 20: Add an additional illustrative research question asking, “How will land use changes mitigate or aggravate transportation-related drivers of climate change?”

DEPARTMENT OF TRANSPORTATION, LAWSON

Page 96, line 24: Following the word "carbon" please add "pool and fluxes,"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 96, line 32 – Why only focus on urbanization?

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 96, line 39: Add an additional payoff, research on greenhouse gas reduction through state and local transportation planning and decision making, 2 years.”

DEPARTMENT OF TRANSPORTATION, LAWSON

Page 97: The timetable here is very fast; I would try it, if I were king, but I'd expect to have to buy some time and talent away from other tasks or risk lowest-common-denominator mush. We already know that poverty and lack of choice reduces the ability to invest in long-term productivity maintenance and capital accumulation, for instance. How hard do we want to relearn that, and how often?

WIENER, INDIVIDUAL COMMENTATOR

Page 97, Chapter 8: coupled climate-land use models would be very useful, and we support the intention to accelerate their development.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 97 first paragraph. The statement on the “…outflow of soil nutrients…” is not true. First of all, this is a very general statement that does not specify which nutrient. Does the writer mean nitrate leaching in agriculture, or in the natural environment such as in forest or rangeland? I am at a loss to think of an instance where this would be a true statement. At what time scale is this statement intended? Does the writer mean an annual time scale or shorter, or at a geologic time scale? I presume the shorter time scale. The writer is making a grandiose statement that is simply not true. Poor soils are poor largely because they starve crops for water, either due to limited rooting profile due to physical limitations or acid subsoils, and/or limited water storage capacity (sandy textures and low organic matter) that is available to crops in a climate that does not provide sufficient rain to overcome the soil water storage limitations. In today's world, fertilizers are cheap and easily make up for any deficiencies in soil fertility for the production of marketable crops.

I propose that there should be a question 6 related to design of communities that make optimum use of land with the minimum effect on greenhouse gas production.. Where should the crops be produced and where should the natural areas be located for optimum ecological benefit and where should housing and business be laid out for optimum use of land? How do you design optimum land use within a given climatic zone? This design would minimize the production of greenhouse gases. This research would depend on intricate linked models for a very complex set of issues. However, scientists should begin to lead the way with research in these complex areas.

SOIL SCIENCE, KISSEL

Page 97, lines 4-13, and p. 98, lines 13-19 have the potential to ignore the historical and dynamic effects of human decisions.

ANN FISHER, PENN STATE UNIVERSITY

Page 97, line 7: Following the word "nutrients" please add "and decline in soil structure"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 97, line 10: Following the words "climate change" please add "soil degradation"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 97, lines 10 -11 – Insert " **and ecological systems sometimes have a more intense reaction when exposed to two or more perturbations**."

VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 97 l 10 …affect natural resources through their effect on ecosystem function. The research…

SOIL SCIENCE, CRUSE

Page 97, line 13: Following the word "cycle" please add "and soil quality"

RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 97, lines 15 – 26. Changes in land cover change surface albedo, which, in turn, will affect the climate system. This feedback should be mentioned under Illustrative Research Questions and estimation of albedo effects incorporated into research needs.

LEONARD S. BERNSTEIN, L.S. BERNSTEIN & ASSOCIATES

Comments on Chapter 8

Page 97, line 16ff: This would be a good place to put in a question about the climatic effects of past changes in land cover (and of past changes in climate—natural and human-induced—on land cover) and how far we are now from equilibrium vegetation cover.
MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 97, Line 16: 16 after agriculture add (e.g. animal and plant production systems)î
BONTA, USDA

Page 97, line 24: Insert a bulleted sentence next to last "What is the impact of future changes in land use and land cover on soil quality, and soil resilience?"
RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 97, line 25-26 – replace "in light of" with "**in order to mitigate the negative impacts of**."
VIRGINIA DALE, OAK RIDGE NATIONAL LABORATORY

Page 97 l 30 …factors and ecosystem function, should be…
SOIL SCIENCE, CRUSE

Page 97, line 37: What is the strategy to do this?
ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. MARYLAND

Page 97, line 39: Replace the word "and" with a comma, and after the word "change" please add "and soil degradation/desertification"
RATTAN LAL, THE OHIO STATE UNIVERSITY

Page 98, line 6: This will likely take more than 10 years to do globally.
MICHAEL MACCRACKEN, LLNL (RETIRED)

Page. 98, line 10 – too vague - national model of what?
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Page 98, line 19 – replace "larger" with "interactive"
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Page 99, references: Recommend reference be correlated to text (via numbers). Also – was there really only one reference used to prepare this Chapter?
DEPARTMENT OF TRANSPORTATION, LAWSON

Page 99, line 1: **(40-E)** Another nit-picking verb problem – I'd reword the first part of this sentence to read:

"Several programs have identified...and have played..."

HP HANSON, LANL

Comments on Chapter 8

Page 99, line 7 --Transportation is only mentioned in the last paragraph, but it is a key aspect of land-use change

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Page 99, line 7 -- Why is the Bureau of Land Management (BLM) called out and not the Department of Interior (the agency under which BLM falls)? Why are other agencies that hold land not mentioned here (e.g., the Department of Defense)?

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Page 99, line 10 – The importance of local land mangers is noted in this last sentence but not elsewhere in the chapter

Several editorial aspects of the writing need to be fixed.
“Land use” and “land cover” are hyphenated when used as adjectives.
There are several places where unnecessary commas are inserted, which inappropriately separate the subject from the verb.

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Page 99, line 12: This single reference is really inadequate—what is the basis for all of these points?

MICHAEL MACCRACKEN, LLNL (RETIRED)