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Land health surveillance and response: A framework for evidence-informed land management

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ABSTRACT

Degradation of land health – the capacity of land, relative to its potential, to sustain delivery of ecosystem services – is recognized as a major global problem in general terms, but remains poorly quantified, resulting in a lack of specific evidence to focus action. *Land health surveillance and response* is designed to overcome limitations of current assessment approaches. It is modelled on science principles and approaches used in surveillance in the public health sector, which has a long history of evidence-informed policy and practice.

Key elements of the science framework are: (i) repeated measurement of land health and associated risk factors using probability based sampling of well defined populations of sample units; (ii) standardized protocols for data collection to enable statistical analysis of patterns, trends, and associations; (iii) case definitions based on specific diagnostic criteria; (iv) rapid low cost screening tests to permit detection of cases and non-cases in large numbers of samples; (v) cost-effectiveness evaluation of interventions based on projected reduction in risks and problem incidence; (vi) design of statistically analysable studies to evaluate interventions in the real-world; (vii) meta-analysis of these data to guide design of public policy and intervention programmes; and (viii) integrating surveillance and the communication and use of results into operational systems as part of regular policy and practice.

The scientific rigour of land health surveillance has potential to provide a sound basis for directing and assessing action to combat land degradation. Specialized national surveillance units should be established to harness and realign existing resources to provide integrated national land health systems. An international unit is needed to provide science and technology support to governments and develop standards, whereas an international agency should coordinate land health surveillance globally. Application of the surveillance framework could result in a shift away from a focus on rehabilitation of severely degraded land towards a preventive approach that focuses more on reducing distal risks at national and regional levels.

1. Introduction

Land degradation (or terrestrial ecosystem degradation) is generally recognized as a major global environmental and development problem, but despite much investment in research and numerous assessments, the degree, extent and impacts of land degradation remain controversial, especially in developing countries (Young, 1998; Koohafkan, 2000; Eswaran et al., 2001; Gisladottir and Stocking, 2005; UNEP, 2007). The lack of specific evidence and information at all scales makes it difficult for international and governmental policy makers to prioritize and direct interventions to improving and protecting land health. Consequently, political backing is often given to human causal relationships that lack empirical support (Lambin et al., 2001; Thomas and Middleton, 1994).

While local participatory and expert-opinion based assessments are important for understanding stakeholder perceptions and the design of local solutions, their lack of standardization prevents aggregation of results and provision of reliable information for decision making and support at higher levels of scale and over time (MA, 2005a; Vogt et al., 2011). Thus a primary problem for large area planning and action is a lack of coherent and rigorous sampling and assessment frameworks that enable comparison of data on land condition across a wide range of environmental conditions and scales, and the integration of such frameworks into decision-making processes at different levels of scale. This

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situation contrasts with the situation in the public health sector, where surveillance is the main source of information guiding decisions and actions in health policy and practice (Teutsch and Churchill, 2000). Therefore surveillance frameworks used in public health management may have much to offer for guiding land health management.

Public health surveillance, which has been active since the 1940s, has been defined in simple terms as "the routine, ongoing collection, analysis, and dissemination of data to those in public health who need to know" (Brookmeyer and Stroup, 2004). It provides the scientific and factual foundation and database for informed decision making and appropriate public health action. We take surveillance to include the full cycle of communication, response and evaluation and not only data collection and dissemination (e.g. Remmington and Nelson, 2010). An example of the contribution of surveillance in the public health sector is the major achievement of the Global Burden of Disease Study, which provided data on incidence and prevalence, by age, sex and region, of over 100 diseases and injuries and a comparative assessment of 20 major risk factors (Lopez, 2005). The data were used to analyse the impact of the different risks on the avoidable future burden of disease, evaluate the cost-effectiveness of alternative interventions and establish clear intervention strategies (WHO, 2002). Nothing comparable exists for assessing the state of the land resource base and for defining intervention strategies at any scale.

In fact land management problems share many of the complex features of public health problems, especially those of non-communicable diseases, and thus similar scientific approaches may be applicable. These similarities include:

1. A rapidly increasing burden of health problems in developing countries, partly linked to demographic factors; and the problems become chronic if not addressed.
2. Problems often occur together as syndromes, with a common set of symptoms, rather than in isolation.
3. Health problems exist as a continuum and there is difficulty in defining the normal case and diagnosing poor versus good health.
4. Problems are associated with a range of physical, biological, social and economic determinants (or risk factors), both at individual and population levels.
5. Risks are often inter-related and act together to cause a health problem. They range from proximal risks acting directly to cause the problem, to distal risks that are further back in the causal chain.
6. Risk factors are often separated from outcomes in time, sometimes by many decades, making it difficult to establish causality.
7. Risks are generally greater for the disadvantaged in our societies, and poverty is a major risk factor.
8. Evaluating the cost-effectiveness of alternative preventive and rehabilitation interventions is complex and must consider many factors. Interventions may cause unintended side effects.
9. Different stakeholder groups (scientists, policy makers, public) perceive risks differently, requiring two-way communication processes.
10. Few resources are allocated to surveillance in developing countries, presenting challenges such as how best to communicate surveillance and research findings in this setting, which still needs much local research.

Given these similarities, the overall goal of this paper is to apply scientific principles used in public health surveillance to the design of a methodological framework for evidence-informed land management and policy, and hopefully stimulate its wide application. The specific objectives are to: (i) elucidate the scientific principles and system components of public health surveillance, (ii) describe their applicability to land health surveillance, and (iii) suggest opportunities for deployment of land health surveillance systems and identify areas for their further research.

2. Principles of land health surveillance

2.1. Definition

The definition of land health surveillance is closely modelled on the definition of public health surveillance given by the Centres for Disease Control and Prevention (Thacker and Berkelman, 2008):

"Land health surveillance is the *ongoing, systematic* collection, analysis, and interpretation of *data* essential to the planning, implementation, and evaluation of land management *policy and practice*, and *application* of these data to promote, protect, and restore land and ecosystem health" (UNEP, 2007). A surveillance system includes a *functional capacity* for data collection, analysis, and dissemination linked to land health programmes. Surveillance aims to provide information for action but excludes research on land health and full-scale implementation of delivery programmes.

Land health is defined here as the capacity of land, relative to its potential, to sustain delivery of essential ecosystem services (the benefits people obtain from ecosystems), which are well described in MA (2003) and Kibblewhite et al. (2008). Land health is not directly equated with human health but rather the scientific conceptual and statistical approaches in land health surveillance are modelled on those employed in public health. The parallels in principles are closer for surveillance of chronic, non-communicable diseases than for communicable diseases.

2.2. Functions

In broad terms the ultimate goal of land health surveillance is to tell us (i) where land problems exist; (ii) whom and what they affect; (iii) where programmatic and prevention activities should be directed; and (iv) how well they are working. Land health surveillance systems are designed to provide timely information for action to improve land productivity and maintain essential ecosystem functions. In more specific terms, land health surveillance has a number of functions (Table 1).

In public health, different types of surveillance systems are used for different purposes (Stroup et al., 2004), and examples of potential parallel applications in land health can be identified (Table 2). These generally follow the progression of surveillance steps of (i) establishing risks to key health problems as a basis for intervention targeting, (ii) evaluating interventions, and (iii) establishing final outcomes. *Integrated* surveillance systems are likely to be of most

Table 1
Principal functions of land health surveillance.

1. Identify land health problems
   - 1.1. Assess and monitor land health status
   - 1.2. Quantify risk factors of land degradation and sustainable land management
   - 1.3. Provide early warning of land degradation
2. Establish quantitative objectives for land health promotion
   - 2.1. Specify objectives for prevention of land degradation
   - 2.2. Specify objectives for land rehabilitation
3. Provide information for the design and planning of land management intervention programmes and resource allocation priorities
   - 3.1. Prioritize intervention areas based on degree and extent of risks to land health
   - 3.2. Prioritize interventions based on cost-effectiveness analysis
   - 3.3. Spatially target interventions
4. Determine the impact of specific interventions
   - 4.1. Empirically test effectiveness of interventions
   - 4.2. Establish outcomes in terms of reduction in risks and health improvement
5. Identify research, service and training needs for different stakeholder groups