



A framework to promote collective action within the One Health community of practice: Using participatory modelling to enable interdisciplinary, cross-sectoral and multi-level integration



Aurelie Binot ^{a,b,*}, Raphaël Duboz ^a, Panomsak Promburom ^c, Waraphon Phimpraphai ^b, Julien Cappelle ^{a,d}, Claire Lajaunie ^e, Flavie Luce Goutard ^{a,b}, Tanu Pinyopummintr ^b, Muriel Figuié ^f, François Louis Roger ^{a,b}

^a CIRAD-AGIRS, Campus international de Baillarguet, F-34398, France

^b Kasetsart University, Faculty of Veterinary Medicine, Chatuchak, Bangkok 10900, Thailand

^c Chiang Mai University, Faculty of Agriculture, Chiang Mai, Thailand

^d Pasteur Institute in Cambodia, Phnom Penh, Cambodia

^e INSERM, Urmite Research Unit, Faculty of Medicine, Marseille, France

^f CIRAD-UMR MOISA, Montpellier F-34398, France

ARTICLE INFO

Article history:

Received 5 June 2015

Received in revised form 31 August 2015

Accepted 3 September 2015

Available online 13 September 2015

Keywords:

Participatory modelling

Knowledge sharing

Multi-stakeholders

Collective action

Cross-sectoral collaboration

Participation

ABSTRACT

As Southeast Asia (SEA) is characterized by high human and domestic animal densities, growing intensification of trade, drastic land use changes and biodiversity erosion, this region appears to be a hotspot to study complex dynamics of zoonoses emergence and health issues at the Animal–Human–Environment interface. Zoonotic diseases and environmental health issues can have devastating socioeconomic and wellbeing impacts. Assessing and managing the related risks implies to take into account ecological and social dynamics at play, in link with epidemiological patterns.

The implementation of a *One Health* (OH) approach in this context calls for improved integration among disciplines and improved cross-sectoral collaboration, involving stakeholders at different levels. For sure, such integration is not achieved spontaneously, implies methodological guidelines and has transaction costs. We explore pathways for implementing such collaboration in SEA context, highlighting the main challenges to be faced by researchers and other target groups involved in OH actions. On this basis, we propose a conceptual framework of OH integration. Throughout 3 components (field-based data management, professional training workshops and higher education), we suggest to develop a new culture of networking involving actors from various disciplines, sectors and levels (from the municipality to the Ministries) through a participatory modelling process, fostering synergies and cooperation. This framework could stimulate long-term dialogue process, based on the combination of case studies implementation and capacity building. It aims for implementing both institutional OH dynamics (multi-stakeholders and cross-sectoral) and research approaches promoting systems thinking and involving social sciences to follow-up and strengthen collective action.

© 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction & context

The implementation of a *One Health* (OH) approach [1–4] cannot be limited to collaborations and improved communication between public health and veterinary medicine stakeholders (the “historical” OH actors). These latter actors are also challenged to collaborate with other actors that should be included within the OH approach, such as environment and agriculture officers, social workers, social scientists, ecological scientists, etc. [5,6]. In this paper, we propose a framework for such an

enlarged OH approach and give examples in the context of Southeast Asia.

Sharing knowledge across OH's researchers

Beyond the implementation of institutional dynamics and cross-sectoral policies, the OH approach can also represent a research topic in itself. Designing an interdisciplinary framework for a better understanding of complex health issues at the Animal/Human/Environment interface is a real challenge for researchers involved into OH projects. Strengthening the interactions between biological, medical and social sciences implies that we should be able to share knowledge among disciplines (veterinary science, medicine, health ecology, geography, economics, sociology of risks, and modelling sciences).

* Corresponding author at: CIRAD-AGIRS, Campus International de Baillarguet, 34 398 Montpellier, France. Tel.: +33 814016739; fax: +33 684513081.
E-mail address: binot@cirad.fr (A. Binot).

For instance, if we have to understand how ecological processes (such as the interactions between hosts and reservoirs, pathogens and the environment and possibly vectors) interact with social processes (risk perception, local practices, power games, surveillance and control measures' acceptability by beneficiaries), we are dealing with a particular research object which does not belong on its own to any discipline. To address this new object, we need to adopt systems thinking (a classical approach in ecology) with a wide range of data [7–9].

Relationships between scientists from different disciplines are mainly driven by controversies regarding the complexity of the research topics raised by the *OH* approach, such as socio-ecosystem based approaches, ecosystem services and ecological functions, social interactions and perceptions at the Animal/Environment/Human interface etc. Scientists hardly speak with one voice [10,11], in particular when it deals with the necessary integration of inputs from social sciences in *OH* research [12–15].

The knowledge in animal health science, public health, social sciences, engineering, ecological and environmental sciences is disseminated among several research institutions. Strengthening synergies represents a real challenge in terms of scientific coordination [16]. Furthermore, the design of specialized curriculums in the field of public health, environment and agriculture in higher education obviously does not promote the emergence of an interdisciplinary scientific culture. Therefore, strengthening sustainably *OH* capacities also requires thinking about “the next generation” and developing *OH* academic training programmes involving public health, veterinary public health and environmental health officers to develop a new culture of interdisciplinarity and systems thinking, involving social and environmental sciences.

Strengthening cross-sectoral institutional collaboration

Beyond this research-based interdisciplinary challenge, the question of cross-sectoral institutional collaboration constitutes another brain teaser [17–19].

Although officers from Veterinary Services and from Public Health appear to have set up ad-hoc collaborations for risk management (for example regarding Avian Flu surveillance and control in crisis times), long-term collaboration with Agriculture (including livestock), Environment and Rural Development sectors remain insufficient.

Ministerial departments are defined together with political national priorities and cannot embrace all relevant topics as a whole. Then, designing knowledge sharing methods and protocols is essential to promote collaboration between various stakeholders who do not have habits of routine collaboration but are embedded in habits to think and work in silo [20].

Involving field based actors and local decision makers

Field-based actions and multi-stakeholders innovations at local level are essential for improving public health in collaboration with other sectors [21,3]. But inter-level relationships (involving civil servants, researchers, international organization members, health workers etc.) are also essential to ensure consistency with national policies and scaling-up. *OH* implementation definitely calls for multi-level and multi-stakeholders approach.

Blending together stakeholders from international organizations (global level), governmental structures (national and provincial levels), and local officers (district and municipality levels) cannot be achieved without adequate methodology for identifying the relevant target groups to get involved, their interests and potential incentives towards cross-sectorial action. It constitutes a recurrent issue for *OH* institutional actors as well as for scientific ones. Recent work shows that modelling, participatory approaches and social sciences' inputs can greatly help driving such an integration process [22–24].

The implementation of OH approach to be implemented in the context of Southeast Asia

Southeast Asia (SEA) particularly needs an effective *OH* approach. This region is characterized by fast environmental changes driven by its economic development and insertion into the global economy. The growing in human and livestock densities and the intensification of cropping and trading lead to drastic land use changes. These changes participate to the erosion of the biodiversity and do impact on the emergence and the burden of diseases [25,26]. SEA region is then at particular risk for new pathogen emergences, and environmental health problems [27,28]. In this context, building bridges among Health, Environment and Agriculture sectors is one of the main challenges that ASEAN community has to handle, in accordance to ASEAN Socio-Cultural Community (ASCC) Council. We are currently involved in a European project to elaborate and implement an enlarged *OH* framework in SEA. We introduce this framework in the following.

Conceptual framework: managing public health as a common public good

As we just highlighted, *OH* is both an institutional movement and a set of research topics that calls for inter-disciplinary, cross-sectoral and multi-level integration. These integration processes call for strong methodological guidelines.

We make the assumption that participatory modelling¹ and social sciences could significantly facilitate this integration. More specifically, participatory modelling could be a great tool promoting One Health collective action and enabling institutional and scientific *OH* integration. We also identify the challenges linked to the implementation of such an integration as well as know-how to take it up, based on an in-depth understanding of *OH* institutional and scientific dynamics at play in the specific context of Southeast Asia.

The conceptual framework that we propose for *OH* integration is focusing on the management of public health and environmental resources viewed as common public goods. Following Ostrom [29], we make the assumption that willingness of cooperation among citizens is the key to successful common good management. It is then crucial to identify pathways towards common and shared interest. Therefore, setting up a community of practice at different levels is supposed to enforce collective action mechanisms. These mechanisms are supposed to help stakeholders going beyond silo thinking, going beyond individual knowledge to manage public goods through collective action influencing individual behaviours [30–32].

We based our conceptual framework on the concept of “community of practice” [33] as it is supposed to drive collective action for *OH* stakeholders. A “community of practices” is defined as “a group of people who share a concern, a set of problems, or a passion about a topic and who deepen their knowledge and expertise in this area by interacting on an ongoing basis” [34]. Being part of the same community of practice means that members frequently interact through both formal and informal settings and share techniques, vocabulary, routines and habits, as well as common perceptions about the issues they address [35,36,32]. We make the assumption that such conceptual framework would significantly help to reveal and explicit interactions between agriculture, environment and health in our context of intervention.

In order to set up this community of practice, integration process needs to be done in a one–two addressing both “institutional” and “scientific” *OH* dynamics. The first objective is to pre-identify relevant issues and dynamics, involving knowledge sharing by researchers within an interdisciplinary analysis grid strongly involving social

¹ See [Setting-up a OH community of practice through participatory modelling](#) section about participatory process.

sciences [35,6]. In parallel, cross-sectoral integration can be targeted in order to highlight and overtake power issues, conflicts of interest and coordination gaps. At each step, focus should be put on stimulating co-operation between stakeholders in order to promote collective action relying on participatory modelling and inputs and highlights provided by social sciences statement and analysis all along the project's implementation [37].

Promoting a new culture for OH systems thinking

Strengthening the OH community of practice in SEA is a real challenge for cross-sectoral and interdisciplinary integration. Routines of collaboration and communication between researchers and decision makers are supposed to be improved through experiential learning from field to laboratory (integrative multidisciplinary tools and methods, participatory approaches) and collaborative field-based work. Such a field based approach could generate heterogeneous data from different sectors and disciplines covering a wide range of health issues at the agriculture and environment interface:

- (1) Addressing specific diseases at the edge of public health (addressing for example the acceptability of vaccination and other control measures), natural resources management (vector control and ecology of reservoirs) and livestock farming systems practices.
- (2) Tackling the issue of institutional coordination for natural resources management (including water) regarding its impacts on public health (flood driven diseases, vector borne disease, waste management from farms, livestock, industry and households and the risk of various environmental contaminations) at different administrative levels.
- (3) Improving neglected tropical diseases management, such as food-borne parasitic zoonoses that are impacting small scale farming and the impacts of raw meat/raw fish consumption could also be a topic of importance, being addressed in link with farmers' livelihoods and cultural habits livestock and fisheries' production systems and public health.

The implementation of field-based work should be relying on parallel training activities (academic and vocational). The overall aim is to build capacities and share knowledge while improving analysis skills in the framework of field based studies, enabling the development of systems thinking applied to OH approach. On the same line, future OH academic curriculums should involve epidemiology, environmental and social sciences, supporting a new culture of cross-sectoral work habits.

The aim of such an approach is to promote a new culture of networking involving actors from various sectors and levels (from the municipality to the Ministries) into long-term dialogue process based on the combination of case studies implementation and capacity building. Civil servants and officers from public health, animal health, agriculture, environment and rural development sectors, laboratory staff, field epidemiologists, veterinarians, ecologists, health workers, social workers and rural development workers are identified thanks to participatory approaches (participatory epidemiology tools and participatory modelling), to be involved in such field studies and linked training activities, regarding specific context and needs. They participate to the development of a new culture of networking and collaboration.

Setting-up a OH community of practice through participatory modelling

Different stakeholders have their own rationales and practices impacting risk management (for example in the field of animal health surveillance systems, water pollution management, food behaviour etc.). These practices and rationales differ regarding the sectors (public

health, veterinarians, environment, land planning, private sector, etc.), the action level (national and provincial officers, international agencies representatives, community based agents and local communities' representatives, etc.) and are shaped by political and economic stakes (cf. trade, commodity chains, land tenure issues, political control etc.). Thus, it represents a real challenge to success involving the stakeholders operating at field level into a participatory modelling process to reveal such sort of divergences in risk perception.

The participatory modelling process starts by defining a question of interest for the relevant stakeholders involved in the case study. Thereafter, the stakeholders co-design conceptual models (diagrams, state charts etc.) that represent the structures (the set of interactions between actors, institutions, the environment etc.) and the dynamics of the system they are interested in (animal production, communication processes, surveillance and control modalities, etc.). By doing this, the relevant stakeholders are involved in a modelling process. During this process, they gather the relevant data and share knowledge, and learn from each other. Thereafter, the model can be simulated considering different scenarios or experiments that have been co-designed by the stakeholders. By analysing the output from the different scenarios, they can explore different pathways to address the question they agree on, revise it if necessary, as well as their models and scenarios, engaging them in a constructivist cycle during which they will collectively improve their ability to tackle a particular issue.

Participatory modelling methodology has been developed 15 years ago for collective decision-making, research and institutional coordination in the framework of natural resources management [38,39]. During the process, the conceptual models are used to design simulators or role-playing games involving the stakeholders in order to stimulate cross-sectoral discussion. The stakeholders generate and play different scenarios, and then evaluate different strategies while learning about the consequences of their decisions in interaction with each-other. The main idea is that participatory modelling, by rendering explicit the biological processes as well as actors' strategies and social relationships, can be used by stakeholders themselves to deal with their own problems to identify mutually accepted solutions that can lead to collective action plans [40].

This approach is supposed to improve coordination across stakeholders from different levels, which is a real challenge in the framework of OH actions. The participatory modelling process should therefore be developed at an administrative scale enabling integration of stakeholders from upper and lower levels. For example, in rural areas of Southeast Asia, we could focus on the "municipality" level as it often operates as a "hub" linking micro-local (villages) and central (through departments of ministries represented at provincial level) stakeholders from public health, agriculture and environment sectors. At the municipal level, huge gaps in communication and coordination appear, for example for the management of hydric and natural resources, with great potential impacts on public health such as proliferation of vectors, risk of bacterial or chemical contamination etc. We assume that provincial and municipal levels could be the relevant ones for the implementation of cross-sectoral action. Indeed, stakeholders of those levels have continuous interactions both with upper ones (which enables upscaling some results to design innovative policies with national stakeholders) and with lower ones (enabling local implementation and concrete management measures with villagers and natural resource users), and can operate as an institutional hub.

Specific case studies should be identified in order to be addressed by participatory modelling in order to set up conceptual models and role playing games that will contribute to improve cross-sectoral coordination, such as: (1) improved coordination for water, natural resources and health management at municipality level; (2) improved communication at provincial level; and (3) improved collaboration between environment, agriculture and health sectors for disease control (vaccination's acceptability, farming practices, and wildlife population management) in rural areas.

Conclusion

The approach related in this paper is currently under development in the framework of the ComAcross *EuropeAid* project. The specific objective is to develop an integrated *OH* approach operational in SEA (Thailand, Laos, and Cambodia) at the Human/Animal/Environment interfaces.

Our action aims at merging various stakeholders, including researchers and policymakers at different levels (from village heads to national officers). This process aims at (1) revealing and strengthening the possible synergies between the various stakeholders involved and (2) enhancing their knowledge and competences to analyse and manage zoonotic diseases and other *OH* issues within a cross-sectoral and interdisciplinary framework.

Yet, this iterative approach that relies on long-term participation of different stakeholders is time consuming and quite slow to implement, which can represent an obstacle for the commitment of some “busy” stakeholders. Furthermore, participatory modelling can reveal tensions and legitimacy issues between “dominant” (historically public health and veterinarian officers) and “non-dominant” (from environment, agriculture and land management sectors) *OH* actors. Indeed, we focus on local perceptions driving behaviours and other qualitative data that could be hardly valuable for *OH* dominant, which are rather shaped by epidemiological rationales. This could even threaten their participation to the modelling process and to the project.

Despite these risks, we assume that designing flexible participatory and iterative work plans taking into account stakeholders’ expectations will significantly contribute to the improvement of cross-sectoral *OH* collaborations.

Acknowledgements

This paper has been written in the framework of the ComAcross project (Companion Approach for Cross-sectoral collaboration in health risk management in SEA) implemented by CIRAD in Southeast Asia. ComAcross involves Kasetsart University (Faculty of Veterinary Medicine), Pasteur Institute in Cambodia, the national University of Laos (Faculty of Agriculture) and the Lao Oxford Mahosot Welcome Trust Research Unit (University of Oxford) in the framework of the INNOVATE (Initiative for new *OH* Ventures in Asia taking Ecosystems into account) *OH* programme in Asia set up by the European Union (EU). This project is implemented (February 2014–January 2018) by CIRAD in the framework of GREASE research network (<http://www.grease-network.org/>)² [41] with financial support of the European Union (EuropeAid, INNOVATE contract 315-047).

The approach developed in the framework of this project has been presented during the *3rd International OH Congress* in Amsterdam in March 2015 during the session entitled “Governance: The research arm of communicating to policy makers and journalists: A scientific approach” and was mentioned again during the session “Ongoing international projects on the chain of emergence (EU/WHO)”, leading to discussion about implementation of interdisciplinary, multi-stakeholders and cross-sectoral *OH* actions involving researchers and decision

² GREASE regional research network (<http://www.grease-network.org/>) promotes a “OH” approach, taking account of the interdependence of social and epidemiological dynamics, biodiversity and health, and veterinary and human public health in order to address such complex health risks. The expected outputs of the network are:

- To boost knowledge of scientists and decision-makers about the dynamics of emergence and transmission and to develop innovative surveillance tools.
- French and Asian students will benefit from training that enables them to take an integrated approach to health risk analysis, within a *OH* conceptual framework.
- Human and veterinary public health, environment and rural development stakeholders will be backed up by knowledge and data that take account of the epidemiological, socio-economic and environmental data for Southeast Asia.
- Producers, livestock supply chain operators, the authorities and local communities will build their skills and organize epidemic surveillance and prevention.

makers. The authors sincerely thank the auditor of *OH Journal* for inviting us to present these communications in the first issue of *OH Journal*.

References

- [1] FAO, OIE, WHO, The FAO–OIE–WHO Collaboration: Sharing Responsibilities and Coordinating Global Activities to Address Health Risks at the Animal–Human–Ecosystems Interfaces: A Tripartite Concept Note, O. FAO, WHO, Rome, Paris, Geneva, 2010 (http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_042011_en.pdf).
- [2] J. Zinsstag, J.S. Mackenzie, M. Jeggo, D.L. Heymann, J.A. Patz, P. Daszak, *Mainstreaming OH*, *EcoHealth* 9 (2012) 107–110, <http://dx.doi.org/10.1007/s10393-012-0772-82>.
- [3] D.F. Charron (Ed.), *EcoHealth Research in Practice*, Springer, New York, NY, 2012.
- [4] J. Zinsstag, E. Schelling, D. Waltner-Toews, M. Tanner, From “one medicine” to “OH” and systemic approaches to health and well-being, *Prev. Vet. Med.* 101 (2011) 148–156, <http://dx.doi.org/10.1016/j.prevetmed.2010.07.003>.
- [5] C.R. James, K.K. Corbett, J.H. Jones, J. Trostle, Emerging infectious diseases: the role of social sciences, *Lancet* 380 (2012) 1884–1886.
- [6] M.K. Lapinski, J.A. Funk, L.T. Moccia, Recommendations for the role of social science research in OH, *Soc. Sci. Med.* 129 (2015) 51–60, <http://dx.doi.org/10.1016/j.socscimed.2014.09.048>.
- [7] F. Berkes, J. Colding, C. Folke, *Navigating Social–Ecological Systems: Building Resilience for Complexity and Change*, Cambridge University Press, Cambridge, UK, 2003 [WWW Document], n.d. URL <http://www.ecologyandsociety.org/vol9/iss1/art1/> (accessed 6.3.15).
- [8] F. Berkes, C. Folke, *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*, Cambridge University Press, Cambridge, UK, 1998.
- [9] B.A. Wilcox, R.R. Colwell, Emerging and reemerging infectious diseases: biocomplexity as an interdisciplinary paradigm, *EcoHealth* 2 (2005) 244–257, <http://dx.doi.org/10.1007/s10393-005-8961-3>.
- [10] G.P. Harrison, D. Ewen Macpherson, D.A. Williams, Promoting interdisciplinarity in engineering teaching, *Eur. J. Eng. Educ.* 32 (2007) 285–293, <http://dx.doi.org/10.1080/03043790701276775>.
- [11] R.B. Norgaard, Ecosystem services: from eye-opening metaphor to complexity blinder, *Ecol. Econ.* 69 (2010) 1219–1227, <http://dx.doi.org/10.1016/j.ecolecon.2009.11.009>.
- [12] S. Craddock, S. Hinchliffe, One world, OH? Social science engagements with the OH agenda, *Soc. Sci. Med.* 129 (2015) 1–4, <http://dx.doi.org/10.1016/j.socscimed.2014.11.016>.
- [13] B. Braun, Environmental issues: inventive life, *Prog. Hum. Geogr.* 32 (2008) 667–679, <http://dx.doi.org/10.1177/0309132507088030>.
- [14] B. Min, L.K. Allen-Scott, B. Buntain, Transdisciplinary research for complex OH issues: a scoping review of key concepts, *Prev. Vet. Med.* 112 (2013) 222–229, <http://dx.doi.org/10.1016/j.prevetmed.2013.09.010>.
- [15] P.A. Conrad, L.A. Meek, J. Dumit, Operationalizing a *OH* approach to global health challenges, *Comp. Immunol. Microbiol. Infect. Dis.* 36 (2013) 211–216, <http://dx.doi.org/10.1016/j.cimid.2013.03.006>.
- [16] D.J. Connell, Sustainable livelihoods and ecosystem health: exploring methodological relations as a source of synergy, *EcoHealth* 7 (2010) 351–360, <http://dx.doi.org/10.1007/s10393-010-0353-7>.
- [17] Working multisectorially in nutrition, in: J. Garett, M. Naticchio (Eds.), *Principles, Practices and Case Studies*, IFPRI, Washington, DC, USA 2011, p. 229.
- [18] J. Waage, R. Banerji, O. Campbell, E. Chirwa, G. Collender, V. Dieltiens, A. Dorward, P. Godfrey-Faussett, P. Hanvoravongchai, G. Kingdon, et al., The Millennium Development Goals: a cross-sectoral analysis and principles for goal setting after 2015: *Lancet and London International Development Centre Commission*, *Lancet* 376 (2010) 991–1023.
- [19] T. Benson, Cross-sectoral Coordination in the Public Sector: A Challenge to Leveraging Agriculture for Improving Nutrition and Health, in: Shenggen Fan, Rajul Pandya-Lorch (Eds.), 2011, p. 145.
- [20] C. Jerolmack, Who’s worried about turkeys? How “organisational silos” impede zoonotic disease surveillance: organisational silos and zoonotic disease surveillance, *Sociol. Health Illn.* 35 (2013) 200–212, <http://dx.doi.org/10.1111/j.1467-9566.2012.01501.x>.
- [21] J. Zinsstag, *OH: The Theory and Practice of Integrated Health Approaches*, Swiss Tropical and Public Health Institute, Switzerland, 2015.
- [22] F. Goutard, A. Binot, R. Duboz, H. Rasamoelina-Andriamanivo, M. Pedrono, D. Holl, M.I. Peyre, J. Cappelle, V. Chevalier, M. Fiquié, S. Molia, F.L. Roger, How to reach the poor? Surveillance in low-income countries, lessons from experiences in Cambodia and Madagascar, *Prev. Vet. Med.* 120 (2015) 12–26.
- [23] E.T.A. Berthet, C. Barnaud, N. Girard, J. Labatut, G. Martin, How to foster agroecological innovations? A comparison of participatory design methods, *J. Environ. Plann. Manag.* (2015) 1–22, <http://dx.doi.org/10.1080/09640568.2015.1009627>.
- [24] M. Leach, I. Scoones, The social and political lives of zoonotic disease models: narratives, science and policy, *Soc. Sci. Med.* 88 (2013) 10–17, <http://dx.doi.org/10.1016/j.socscimed.2013.03.017>.
- [25] B.A. Jones, D. Grace, R. Kock, S. Alonso, J. Rushton, M.Y. Said, D. McKeever, F. Mutua, J. Young, J. McDermott, D.U. Pfeiffer, Zoonosis emergence linked to agricultural intensification and environmental change, *Proc. Natl. Acad. Sci.* 110 (2013) 8399–8404, <http://dx.doi.org/10.1073/pnas.1208059110>.
- [26] J.H. Leiber, J. Otte, D. Roland-Holst, D.U. Pfeiffer, R. Soares Magalhães, J. Rushton, J.P. Graham, E.K. Silbergeld, Industrial food animal production and global health risks: exploring the ecosystems and economics of avian influenza, *EcoHealth* 6 (2009) 58–70, <http://dx.doi.org/10.1007/s10393-009-0226-0>.

- [27] D. Grace, J. Gilbert, M.L. Lapar, F. Unger, S. Fèvre, H. Nguyen-Viet, E. Schelling, Zoonotic emerging infectious disease in selected countries in Southeast Asia: insights from EcoHealth, *EcoHealth* 8 (2011) 55–62, <http://dx.doi.org/10.1007/s10393-010-0357-3>.
- [28] S. McLafferty, Placing pandemics: geographical dimensions of vulnerability and spread, *Eurasian Geography and Economics* 51 (2) (2010) 143–161.
- [29] E. Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (Political Economy of Institutions and Decisions), Cambridge University Press, 1990.
- [30] Avian influenza, in: I. Scoones (Ed.), *Science, Policy and Politics* (Pathway to Sustainability). London, Washington DC, 2010.
- [31] J.D. Mayer, Geography, ecology and emerging infectious diseases, *Soc. Sci. Med.* 50 (2010) 937–952.
- [32] C. Richmond, S. Elliott, R. Matthews, B. Elliott, The political ecology of health: perceptions of environment, economy, health and well-being among 'Namgis First Nation', *Health Place* 11 (2005) 349–365, <http://dx.doi.org/10.1016/j.healthplace.2004.04.003>.
- [33] P. Eckert, Communities of practice, in: K. Brown (Ed.), *Encyclopedia of Language and Linguistics*, Elsevier, New York, USA 2006, pp. 683–685.
- [34] E. Wenger, R.A. McDermott, et al., *Cultivating Communities of Practice: A Guide to Managing Knowledge*, Harvard Business School Press, Boston, Mass, 2002.
- [35] L.C. Li, J.M. Grimshaw, C. Nielsen, M. Judd, P.C. Coyte, I.D. Graham, Evolution of Wenger's concept of community of practice, *Implement. Sci.* 4 (2009) 11, <http://dx.doi.org/10.1186/1748-5908-4-11>.
- [36] M.C. Paul, M. Figuié, A. Kovitvadhi, S. Valeix, S. Wongnarkpet, C. Poolkhet, S. Kasemsuwan, C. Ducrot, F. Roger, A. Binot, Collective resistance to HPAI H5N1 surveillance in the Thai cockfighting community: insights from a social anthropology study, *Prev. Vet. Med.* 120 (2015) 106–114, <http://dx.doi.org/10.1016/j.prevetmed.2015.02.021>.
- [37] E. Ostrom, Collective action and the evolution of social norms, *J. Econ. Perspect.* 14 (2000) 137–158.
- [38] Companion modelling, in: M. Etienne (Ed.), *A Participatory Approach to Support Sustainable Development 2013*, p. 403 Éditions Quæ, Versailles, France.
- [39] T.R. Gurung, F. Bousquet, G. Trébuil, Companion modeling, conflict resolution, and institution building: sharing irrigation water in the Lingmuteychu Watershed, Bhutan, *Ecol. Soc.* 11 (2006) 36.
- [40] P.C. Campo, F. Bousquet, T.R. Villanueva, Modelling with stakeholders within a development project, *Environ. Model Softw.* 25 (11) (2010) 1302–1321.
- [41] J. Cappelle, A. Binot, V. Chevalier, M. Desquesnes, R. Bubo, F. Goutard, S. Morand, M. Peyre, F. Roger, CIRAD's platform in partnership (GREASE) activities on zoonoses in South East Asia, *Joint APHCA–OIE Regional Workshop on Zoonoses, Food-borne Diseases and Antimicrobial Resistance 2013*, pp. 37–44.