Title: The dynamics and control of zoonotic diseases: interdisciplinarity, social sciences and participatory epidemiology in perspective

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Abstract

This paper reviews the nature of interdisciplinary research in relation to One Health, a perspective on human-animal health which would appear to merit close interdisciplinary cooperation to inform public health policy. We discuss the relationship between biological sciences, epidemiology and the social sciences and note that interdisciplinary work demands attention be given to a range of epistemological and methodological issues which are often neglected. Veterinarians (and human doctors) sometimes adopt social science techniques as "bolt-ons" to their research without understanding how the social sciences work. The paper introduces a range of social science concepts and applies them to the challenges of understanding and practicing "participatory" and "local" epidemiology. It considers the problem of co-production of knowledge about One Health and zoonotic diseases in relation to funding structures, working in large international teams and explores some of the often-neglected realities of working across disciplines and cultures. It does this in part by applying the concept of "value-chain" to the research process.

Keywords

Local epidemiology; participatory epidemiology; discourses; interdisciplinarity; social sciences; value chains

The limitations of current technical and didactic approaches to addressing health issues at the human-animal interface in resource poor settings

'A "OneHealth" framework applied to brucellosis and other endemic zoonoses should encourage actors from the medical, veterinary, wildlife and sociological disciplines to contribute to a holistic understanding of the disease. Gross simplification of the real situation will not help. Professional, scientific and well documented contributions should result in consensual and effective control strategies, which should be seen as an important added value from a societal perspective.' (Godfroid et al., 2013)

The One Health approach to the animal-human health interface has at its centre the view that animals and humans occupy a continuous health space. Such an approach requires that human behaviour be taken into account in both understanding and responding to zoonotic diseases (Pfeiffer et al., 2013). The goals are admirable and might indeed contribute to human and animal welfare. However, pursuit of such understandings have lacked proper conceptualisation with regard to how such an approach might occur in practice, specifically how to achieve an "holistic understanding" and inclusion of "sociological disciplines" is the subject of this paper, a paper which takes as its point of departure that we do not know how to do interdisciplinarity, we do not know how to achieve "holistic understanding" and interventions with regard to both human and animal health (usually taken separately) fail to take account of human behaviour in relation to "sociological disciplines", instead adopting a broad public health perspective or an individual behavioural perspective. Epidemiology tends toward the broad systemic account, psychology and social psychology inhabit the space of individual behaviour and behavioural "solutions" to the problems. In contrast, the "sociological disciplines", notably but not exclusively sociology, social anthropology, neo-classical economics, political economy and political science offer the "excluded middle" (Boswinkel, 1966), true engagement with "the social" – for it is "the social " which is their object of study. Discussions of "participatory epidemiology" and other such techniques tend to see the social sciences as "bolt-on" additions to existing ways of doing things in human and veterinary medicine, additions for

forming policy. In this paper we suggest that the questions of interdisciplinary conceptualisation, problem specification and policy formation are more complex and require far more thought than those suggested by the tempting (and simplistic) practice of the bolt-on. In doing this we can make progress toward avoiding the "gross simplification of the real situation" referred to above. We must engage with the complexity of situations of the world of zoonoses and human behaviour – that is the way forward.

Here we discuss some key questions relating to interdisciplinarity, epidemiology, participatory epidemiology and local epidemiology (Fischer and Chenais, 2019). Clarification of these questions as they apply to the difficult practice of interdisciplinary research, may contribute to our understanding and response to infectious diseases and their effects on human and animal health and welfare.

Epidemiology has been successful in identifying factors promoting and preventing a range of infections, and in developing interventions which could effectively reduce, or even eliminate, the risk and /or the consequences of these infections. These interventions always rely, to a certain degree, on behaviour change(s) among targeted populations. Even if intervention takes the form of novel and sophisticated technologies such as a vaccine or treatments, their epidemiological outcomes still ultimately depend on levels of uptake by humans. Uptake rates are closely connected to how people understand and speak to each other about inoculation, vaccines, their use, efficacy, safety, side effects, cost and, indeed, how these technologies are produced and marketed (Larson, 2016; Pollock, 2019). For the most part, behaviour change depends heavily on didactic approaches – telling people what is the right thing to do and persuading them to do it. Yet, even for the most affordable and effective technologies, focusing interventions solely or centrally on individual behaviour change alone (Michie et al., 2014) (particularly those based on Knowledge, Attitudes, Behaviours and Practice [KABP] studies) can be met with limited success, as indeed may also those dependent on regulation. This may be because didactic approaches ignore the social, economic, historical and cultural factors which bring into being those behaviours and the resulting *risk environments* (Barnett and Blaikie, 1992) (Barnett and Whiteside, 2002) in the first place. In the case of animal production

and trading for example, the structure of supply chains, profit margins, scales of production, local political organisations, may all play a significant role in determining producers' and traders' propensity to adopt or practice good hygiene, vaccination, bio-security, food hygiene and the host of other links in the chain which convert living creature into a food item (Fournié et al., 2017; Høg et al., 2018).

Social science**s** provide ways of analysing the contribution of social, economic, historical and cultural factors in forming the environments within which and by means of which many biological processes take place. This is because human actions and beliefs form the matrices within which many biological cause and effect pathways come into existence. If effective interventions are to be designed, the biological and the social realms should be seen as constituting a continuous space wherein these realms are entwined (Bourdieu et al., 1987). To do this requires interdisciplinary work and, and as has been already noted, such interdisciplinary working is often said to be a good thing. But it is rarely practised and the challenges to such work are significant. This paper reviews some of these challenges in relation to technical engagement with informing policy and effective interventions. It confronts the difficulty that in some respects the "natural" sciences and the "social" sciences seem to occupy quite distinct intellectual universes at worst and only tangentially overlapping intellectual universes at best. This is most evident where "natural" scientists seek and claim "objectivity" while "social" scientists may also seek it but explicitly deal with study objects, among which is their own social and cultural position, and that the people they study inhabit subjective worlds of meaning, meanings that affect what they do and how the understand what they do. The situation is not helped by the fact that few social scientists know much about biological sciences and few biological sciences know much about social sciences.

Epidemiology and One Health as *discourses*

Two current theoretical terms in social science are *discourse* and *narrative*, the stories that people tell themselves and others about the way the world "is". *Discourses* may be thought of as big stories (for example about nations, ethnicities, gender relations, peoples, histories, traditions) while *narratives* may be thought of as smaller stories. Among these discourses and narratives are, perhaps disappointingly for "natural" scientists reading this, those of "objectivity" and indeed "science". Both are considered by social scientists as constructions of specific historical societies and epochs. Social science concepts (as with the terms *discourse* and *narrative*) are italicised in what follows. This is to indicate their use as technical terms. Each of these is accompanied by citations which offer, in the spirit of interdisciplinarity, pointers should non-social scientists wish to pursue those ideas further. None of the foregoing is to be taken as suggesting that the present authors consider science as *merely* a social construction; rather it is to note that social scientists problematise science through the concept of *discourse* to better understand the role it plays in human affairs. And we should not forget that "science" has been used to provide "evidence" for and legitimation of, among other things, biological and eugenic theories of racial and class selection (Bix, 2018) (Levine, 2017).
Since humans took up farming, close connection between humans and the diseases of animals with which they interact have become more intense (Wolfe ND et al., 2012; Harari, 2015; Scott, 2017). With increasingly rapid and accelerating intellectual movement and human spatial expansion over many centuries toward what we now describe as "globalisation", sharing of spaces of all degrees of intimacy and remoteness between microscopic life forms, animals and plants is rapidly overtaken by and encompassed within a range of discourses (Keller, 2011), among these is *One Health*.
Describing *One Health* as a *discourse* (Aronowitz, 1988; Dunn, 2016) is to note that the idea of One Health is not a neutral descriptive label. To describe it as a *discourse* is to show that, from a social science perspective, words have consequences and are often associated with *power* (Swartz, 1997) (Weber and Parsons, 1947). One aspect of power is in the framing of problems and thus to affect

processes whereby resources are allocated. Not only is *One Health* a *discourse*, situated as it is in the space between science and policy, so too is science itself.

The latter has been investigated in many different ways, most influentially in the last century by philosophers of science such as Karl Popper (Popper, 2002) and by sociologists of science, notably Thomas Kuhn (Kuhn, 1996). Other approaches to the understanding of discourses extend into the tradition of *hermeneutics* (Zimmerman, 2015). In short, *discourses* are important topics of investigation by social scientists. They are objects which are problematised and studied by the social sciences, particularly those concerned with culture and *imaginaries* (Strauss, 2006). Such objects may include the social sciences themselves, for example the highly rationalistic and quantitative school of economics known as *neo-classical economics* (Ferguson, 1969) (Mirowski, 1989). Critical approaches from the perspective of discourse can assist in thinking around and through taken for granted knowledges as to nature of what kinds of things zoonosis, emergence, risk, health, disease and policy "are" (Canguilhem, 1978; Spicker, 1987; Foucault, 1989, 2013; Bourke and Lidstone, 2015).

Any discourse may be subjected to critical examination, policy discourses among them. These are in their nature problematic, and *One Health* is no exception. They engage constructive ambiguity, differences of perspective, interests, cultures and most important power – the latter in its broadest sense - over resources, ideas and human bodies. That this is the case is discussed and analysed at length by Galaz et al (Galaz et al., 2015) in relation to *One Health*, and by Davies in relation to the politics of implementing International Health Regulations (Barnett, 2019; Davies, 2019). An illustration of the ways that discourses operate is the term "tropical" diseases (Farrar et al., 2013). It emerged as an apparently neutral descriptive category marked by geography but has subsequently been partially replaced by other nomenclatures – zoonotic, emerging, diseases of poverty. This transition is an example of how description is itself problematic and often carries changing markers of difference between human beings, their needs, entitlements and rights. Hysteresis, the location of something in relation to the history of the system of which it is a part, is of the greatest

importance for understanding the relations between pathogens, disease, humans and animals, and policy practices (McNeill, 1976; Farmer, 1999; Goudsmit, 2004; Barnett and Whiteside, 2006; Iliffe, 2006; Moalem, 2007; Byrne, 2008; Pepin, 2011).

Interdisciplinarity: epistemological and practical challenges in working between disciplines and cultures

The notion of *narrative* (Gubrium, 2009) (Holstein, 2000) engages the framing of a problem, objects of research and the technical ways in which such objects can be examined in practice (the methods). These concerns go to the heart of interdisciplinarity and interdisciplinary practices. They are important in turn for understanding how we should think about two related activities: participatory epidemiology and the co-production of knowledge. First, we consider interdisciplinarity, and we consider it in relation to science, which is, as we have noted, a particular *discourse*.

Interdisciplinarity may be thought of as participation of multiple disciplines to address questions scientifically and inform policy. That this work is "scientific" points to the way in which cross disciplinary work undertaken with researchers from different cultures and traditions demands that such work is understood as forming part of that internationally understood *discourse* of "science". That discourse has characteristic assumptions and perspectives about how we should think. It is these that research teams must accept if interdisciplinary scientific work is to be possible at all. The alternative is to become lost in an infinite deconstructive wilderness of theoretical mirrors (Martin, 2003) and perspectives, where, in the words of Karen Barad, *"Discourse matters. Culture matters. There is an important sense in which the only thing that does not seem to matter anymore is matter."* (Barad, 2003).

Sensitivity to these differences of often epistemological perspectives in such an enterprise requires that scientists involved in the research endeavour to achieve some understanding of what different disciplines might offer and in particular the ways that they see the world via the particular discipline (assumptions and rules as to evidence, hypothesis formation, structures and forms of argument, traditions and taken for granted knowledge) of their discipline**s**. Above all it is vital that researchers working within a scientific frame do not forget that science is and should always be critically deconstructive and questioning of established knowledge and theories (Rovelli, 2015). That is its essence as a specific dominant way of thinking about the world (Barthes and Duisit, 1975;

Czarniawska-Joerges, 2004). From a social science perspective, it is at this point that the question of *narratives* within the scientific discourse becomes important in relation to four aspects of research activity. These are: (a) the definition of problems to be studied; (b) the research process and the instruments to be deployed; (c) the voice in which the authority of the author(s) is expressed; (d) the subsequent development, articulation and authority claims of any translation of scientific findings into policy. In the next section, we illustrate some of the ways that these factors interact by considering in general terms the conceptualisation and use of the very frequently deployed term "risk".

Understandings of risk: scales, perspectives, narratives, politics and the distribution of research funds

We begin with a conventional working definition of three key terms: hazard, risk and uncertainty. Hazard is a possible source of harm, risk is the chance, high or low, that a hazard will actually cause harm, and uncertainty is a statement of the probability of knowing about the extent of risk and judgement of how good our knowledge is in estimating that probability. These definitions may appear familiar. But from a social science perspective they are culturally and linguistically embedded and relate to the concepts of *narrative* and *discourse* which have been discussed above.

It is a truism that not everybody (including research teams from different cultures as well as different people within a nation state or cultural group) sees hazard, risk (or probability) and uncertainty in the same way. Put simply: (a) different social groups have different assessments of hazard and the associated risk; (b) definition of any particular risk or hazard differs between the scale of the "system" which is being considered – put crudely, national or local, men or women and many other categories reflecting the dynamic and fluid diversity of all human societies; (c) scale and definitions feed into and define narratives. This point has important implications. **What** is investigated, **how** it is investigated and the resulting **story** that will be communicated to the research end-users depends on who exercises power over the creation of both the research narrative (identifying and defining the object of research) and the policy narrative. These narratives are, after all, reflections of the ways in which power is organised in social life. They are not necessarily "rational" in the simple sense that everybody agrees on the right way forward.

To give extremely clear divergent examples of this problem. A few laboratory-based life scientists, veterinarians and human clinicians may see "the problems" (or even the "causes") of zoonotic transmission risk as inhering in the behaviour of poor, illiterate and ignorant individuals and the solution in didactic interventions with those individuals. Some social scientists may see the "problems" (or "causes") as inhering in the ways that poor people's marginal livelihoods drive them to take risks because they have to survive from day to day and therefore take short term risks. These

divergent views reflect the strong possibility that epidemiologists setting out to investigate the association between behaviours and disease are not looking at the same object of study as social scientists who set out to explore the socio-economic structural factors which underly those presumed associations. This is where the tangential relationship between natural and social sciences, briefly touched upon above, is most clearly seen. It often results in natural and social scientists disagreeing as to the objects of research, and, as is so often the case, in social sciences merely playing the role of extra in the main drama (the "bolt-on"), the "real" scientific research done on pathogens in laboratories. Yet, it is here that the role of *narratives*, taken for granted knowledges, and politics of the exercise of power (economic, gender, symbolic) may intersect in co-producing understandings of the relationship between pathogens, their hosts, people, their behaviours, their livelihoods and the *political economy* (Wittman and Weingast, 2008) of an entire sector of production, from concentrated corporate ownership of intellectual property in the genetic material of livestock strains to chopped up meat ready for the pot (Polanyi, 1957; Wittman and Weingast, 2008; Wallace, 2009; Wallace et al., 2010; Piketty, 2014; Wallace et al., 2015). It is exactly at this intellectual point that this kind of interaction, fruitful co-production between social and natural scientists, can and should take place.

As the presumed nature of the object of study may greatly differ across and between disciplines, so prioritisation of the risk to be investigated and its framing (for example as a potential global pandemic or a risk to the health of a few isolated chicken farmers) will also be affected by who is able to set the research agenda. For instance, what is defined as a major risk at the international level or for the "global community" (as in the case of highly pathogenic avian influenza – HPAI) may not be a problem at all for national health services (Davies, 2019) and small-scale farmers who manage endemic diseases in their flocks as a day to day normality. The overarching implication is that in a world of competing narratives and inequalities of power, wealth and cultural prestige, policy which engages with risk and hazards associated with human and animal diseases should endeavour to take all these perspectives into account. Yet some versions of One Health or the

International Health regulations can end up ignoring certain risk perspectives, local and even national (Davies, 2019). This is a huge challenge for those who research bio-medical issues whether from a laboratory or social sciences perspective.

Furthermore, working across disciplines and perspectives is constrained by the tempo of research funding and evaluation. The questions of narratives and power are nowhere more evident than when researchers are judged by how far their science results in "policy outcomes" which may, in practice, be very short-term given that the life of a funded project rarely exceeds five years. The question of time perspective for research outcomes is very important in the constant competition for research funding. Nowhere is this more apparent than when, for example, criteria of success are contained within a management tool such as the "theory of change" (Taplin and Clark, 2012). This project management design tool, adopted by funding agencies of some major donor countries, embeds "policy relevance", "participation", "sustainability" and other policy outcomes into large-scale projects and can threaten to have perverse outcomes where the output tail wags the research strategy dog. While the "theory of change" planning tool is intended to encourage research teams to cooperate and consult in the participatory development of goals, activities and outcomes, in practice given the time scale for funding applications, it can turn out to be highly managerial rather than at all participatory. When the emphasis is on its managerial function, it can bend scientific research programmes to fit with existing government strategies under the guise of creating "new knowledge". In such a context, funding sources, government strategies, research institutes' hunger for finance, and individual career aspirations may all combine to exclude the complex detail of the lives of poor people, the fine textured questions of environmental sustainability (Scheffer, 2009; Scheffer et al., 2009; Scheffer, 2010), understanding of the long term nature and deep socio-economic roots of risk, and thus long term policies, instead identifying politically acceptable "policies" - often couched in the *faux* radical language of the development aid sector (Ferguson, 1985; Grillo and Stirrat, 1997; Tribe, 2010).

In this section we have seen how consideration of such apparently straightforward notions as risk, hazard and uncertainty, all stock in trade to those working in public health and One Health, may appear less than straightforward from a social sciences perspective. Social science perspectives often (irritatingly) problematise the "straightforward"/taken for granted narratives, methods and even research objects assumed as unproblematic by their natural science colleagues. This is the case with regard to the ideas and practices of participation and co-production of knowledge.

What does it mean to "participate" and to "co-produce" knowledge?

Participatory epidemiology is described as:

"... the systematic use of participatory approaches and methods to improve understanding of diseases and options for animal disease control. This definition refers to both a 'participatory approach' and 'participatory methods', indicating that an understanding of both approach and methods are needed to define PE. We propose that the term 'participatory' in PE is used to refer to the essential involvement of communities in defining and prioritizing veterinary-related problems, and in the development of solutions to service delivery, disease control or surveillance. As we explain later in the review, use of the term PE that does not involve communities in these ways is considered to be a misnomer." (Catley et al., 2012), p. 151.

And as Catley et al indicate, this largely veterinary creation owes a great deal to work on participation in relation to rural appraisal and planning by the distinguished development policy thinker, Robert Chambers (Chambers, 1974, 1997; Chambers, 2007) whose concern with non-participation doubtless has some of its roots in his early career in the British colonial civil service in Kenya explored in his study of centralised (and securitised) irrigation developments as part of the British colonial government's efforts to combat civil unrest and opposition to colonial rule in the early 1950s (Chambers, 1969).

"Local" epidemiology is a response to the extractive nature of some "participatory" epidemiology (PE). Fischer and Chenais note that:

"...more research in epidemiology is needed that is truly participatory and considers local heterogeneity and power. This version of PE can usefully be influenced by the methodological development of participatory research."

and

"when aiming for (semi)quantitative results, or when research cannot be fully open to community participation, traditional, less participatory PE will still be useful. To avoid false expectations, we suggest renaming this version of PE as 'local epidemiology'." (Fischer and Chenais, 2019)

There is a long tradition of intellectuals and politicians claiming privileged access to the minds of "the people". Practitioners of "participatory" techniques of investigation must navigate the treacherous seas between the jagged rocks of making unsustainable assumptions, infantilising "the people", inventing and/or homogenising social groups, merely extracting information in a characteristic uneven exchange (Emmanuel, 1975). There is also the danger of assuming an imperious authorial voice about the lives and ideas of others, all delivered in the name of "science". "Participation" can all too easily become a way of legitimising a research (or political) community's view of the world. It has appeared in various forms and can be traced back historically to, for example (but by no means solely), the Narodnik[1] movement in nineteenth century Russia (Pedler, 1927; Chayanov, 1986). At a conceptual level the notion of "participation" must be used sensitively as it can reify "communities" and attribute significance to certain differentiations between human beings which are the object of investigation, while failing to observe that such "communities" are often internally differentiated (not least by income, ethnicity, gender, belief, age). When this is done, use of such participatory tools as transects, focus groups, village (or other spatial) mapping, role plays, &c while producing "knowledge" may not involve co-production of knowledge as between the investigator and the "community" and may instead err seriously, as outsiders search for "genuineness" in "communities" (Chambers, 2007) . Co-creation of knowledge which involves shared decision-making demands that we recognise that co-production is a challenging process requiring role clarity, constant attention to power imbalances, difficult discussions about research rigour versus research relevance, and constant monitoring (Oliver et al., 2019). It also means putting in place the mechanisms to support these demanding activities, working across scales, across diverse and divergent interest groups and stakeholders. Above all – if we are honest – it is likely to involve complex debates about the nature of "evidence" and the way that putative co-producers understand knowledge itself.

[1] Populist

Participation at different scales will also produce competing world views and reveal different interests. This observation engages a key point: it is not only the usual suspects in the categories of the deprived, powerless and excluded who miss out in the process of co-production. They are of course vital participants. But the world is stratified and fragmented in many and fluid ways to produce structural exclusion and disadvantage of many different kinds. And in our epidemiological investigations we should not always jump to the most easily identifiable excluded or vulnerable population fragments while ignoring the diverse loci of disempowerment in the *value chain* of the research process itself (Kaplinsky, 2000; Harriss-White, 2014). These value chains run from funding bodies (e.g. national governments, philanthropic or political foundation), through research institutions in different countries, to people on farms and forests, in trade networks, in families, local associations, to policy think tanks and back to governments and NGOs. It is in this complex ecology of the scientific research process that we must assiduously seek both our understanding and our practice of participation in and co-production of knowledge (Oliver et al., 2019).

Such knowledge should always be located within the discourse of science, a discourse which, constrained and limited as are all discourses, has the advantage of being subject to constant critique specification of "evidence" and reformulation, and located in relation to the material world (Barad, 2003). In this context the following quotation, combining ideas from science, philosophy, human history and meat consumption, is both amusingly and seriously relevant to the questions addressed in this paper:

"When we talk about the Big Bang or the fabric of space, what we are doing is not a continuation of the free and fantastic stories which humans have told nightly around campfires for hundreds of thousands of years. It is the continuation of something else: of the gaze of those same men in the first light of day looking at tracks left by antelope in the dust of the savannah – scrutinizing and deducting from the details of reality in order to pursue something which we can't see directly but can follow the traces of. In the awareness that we can always be wrong, and therefore ready at any moment to change

direction if a new track appears; but knowing also that if we are good enough we will get it right and will find what we are seeking. This is the nature of science. The confusion between these two diverse human activities – inventing stories and following traces in order to find something – is the origin of the incomprehension and distrust of science shown by a significant part of our contemporary culture. The separation is a subtle one: the antelope hunted at dawn is not far removed from the antelope deity in that night's storytelling. The border is porous. Myths nourish science, and science nourishes myth. But the value of knowledge remains. If we find the antelope we can eat." (Rovelli, 2015)

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References

Aronowitz, S., 1988. Science as power discourse and ideology in modern society. University of Minnesota Press Minneapolis.

Barad, K., 2003. Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter. Signs: Journal of Women in Culture and Society 28, 801-831.

Barnett, T., 2019. A complex minuet: behaviour change at the large scale. The Lancet: Infectious Diseases 19, 1067-1068.

Barnett, T., Blaikie, P.M., 1992. AIDS in Africa: Its Present and Future Impact. Belhaven Press, London and Guildford Press New York.

Barnett, T., Whiteside, A., 2002. AIDS in the 21st century: disease and globalisation. Palgrave Macmillan London.

Barnett, T., Whiteside, A., 2006. AIDS in the twenty-first century : disease and globalization. Palgrave Macmillan Basingstoke England ; New York.

Barthes, R., Duisit, L., 1975. An Introduction to the Structural Analysis of Narrative. New Literary History 6, 237-272.

Bix, A., 2018. Molly Ladd-Taylor. Fixing the Poor: Eugenic Sterilization and Child Welfare in the Twentieth Century. Journal of the History of Medicine and Allied Sciences 73, 525-527.

Boswinkel, E., 1966. J. L. Ackrill, Aristotle's Categories and De Interpretatione. Translated with Notes (Clarendon Aristotle Series). Oxford, Clarendon Press, 1963. VII, 162 p. Pr. sh. 25. Mnemosyne 19, 103-103.

Bourdieu, P., Nice, R., Nice, R., 1987. Distinction : a social critique of the judgement of taste.

Bourke, T., Lidstone, J., 2015. What is Plan B? Using Foucault's archaeology to enhance policy analysis. Discourse: Studies in the Cultural Politics of Education 36, 833-853.

Byrne, J.P. (Ed.), 2008. Encyclopedia of pestilence, pandemics, and plagues. Greenwood Publishing Group Inc Westport, CT.

Canguilhem, G., 1978. On the Normal and the Pathological. D. Reidle Publishing Co. Dordrecht, Holland.

Catley, A., Alders, R.G., Wood, J.L.N., 2012. Participatory epidemiology: Approaches, methods, experiences. The Veterinary Journal 191, 151-160.

Chambers, R., 1969. Settlement schemes in tropical Africa : a study of organizations and development. Routledge & Kegan Paul London.

Chambers, R., 1974. Managing rural development : ideas and experience from East Africa. Scandinavian Institute of African Studies Uppsala.

Chambers, R., 1997. Whose reality counts? : putting the first last. Intermediate Technology London.

Chambers, R., 2007. Participation and Poverty. Development 50, 20.

Chayanov, A., 1986. A.V. Chayanov on the theory of peasant economy. Manchester University Press Manchester.

Czarniawska-Joerges, B., 2004. Narratives in social science research. SAGE London.

Davies, S.E., 2019. Containing Contagion: the politics of disease outbreaks in South East Asia. Johns Hopkins Press Baltimore, USA.

Dunn, K.C., 2016. Undertaking discourse analysis for social research. University of Michigan Press Ann Arbor.

Emmanuel, A., 1975. Unequal Exchange Revisited. IDS Discussion Paper 77.

Farmer, P., 1999. Infections and Inequalities: the modern plagues. University of California Press Berkeley, Los Angeles, USA.

Farrar, J., Hotez, P., Junghanss, t., Gagandeep, K., lalloo, D., White, N., 2013. Mansons' Tropical Diseases 23rd edition. Elsevier, Saunders Lst.

Ferguson, C.E., 1969. The neoclassical theory of production and distribution. C.U.P.

Ferguson, J., 1985. Discourse, knowledge and structural production in the "development" industry: an anthropological study of a rural development project in Lesotho. Thesis (Ph.D.)--Harvard University, 1985.

Fischer, K., Chenais, E., 2019. What's in a name: Participatory epidemiology. Preventive Veterinary Medicine 165, 34-35.

Foucault, M., 1989. The birth of the clinic : an archaeology of medical perception Routledge London, UK.

Foucault, M., 2013. Archaeology of Knowledge. Routledge London, UK.

Fournié, G., Høg, E., Barnett, T., Pfeiffer, D.U., Mangtani, P., 2017. A Systematic Review and Meta-Analysis of Practices Exposing Humans to Avian Influenza Viruses, Their Prevalence, and Rationale. The American journal of tropical medicine and hygiene 97, 376-388.

Galaz, V., Leach, M., Scoones, I., Stein, C., 2015 The political economy of One Health research and policy. STEPS Working Papers STEPS Centre, University of Sussex, Brighton, UK.

Godfroid, J., Al Dahouk, S., Pappas, G., Roth, F., Matope, G., Muma, J., Marcotty, T., Pfeiffer, D., Skjerve, E., 2013. A “One Health” surveillance and control of brucellosis in developing countries: Moving away from improvisation. Comparative Immunology, Microbiology and Infectious Diseases 36, 241-248.

Goudsmit, J., 2004. Viral Fitness: the next SARS and West Nile in the making. Oxford University Press Oxford, UK.

Grillo, R.D., Stirrat, R.L., 1997. Discourses of development : anthropological perspectives. Berg Oxford.

Gubrium, J.F., 2009. Analyzing narrative reality. SAGE London.

Harari, N.Y., 2015. Sapiens: a Brief History of Humankind. Vintage London.

Harriss-White, B., 2014. Labour and Petty Production. Development and Change 45, 981-1000.

Høg, E., Fournié, G., Hoque, M.A., Mahmud, R., Pfeiffer, D.U., Barnett, T., 2018. Competing biosecurity and risk rationalities in the Chittagong poultry commodity chain, Bangladesh. BioSocieties.

Holstein, J.A., 2000. The self we live by : narrative identity in a postmodern world. Oxford University Press New York ;.

Iliffe, J., 2006. A History of the African AIDS Epidemic. James Currey Oxford, UK.

Kaplinsky, R., 2000. Spreading the gains from globalisation: what can be learned from value chain analysis? In: Insitute of Development Studies (Ed.).

Keller, R., 2011. The Sociology of Knowledge Approach to Discourse (SKAD). Human Studies 34, 43-65.

Kuhn, T.S., 1996. The structure of scientific revolutions. The University of Chicago Press Chicago, Illinois, USA ; London, UK

Larson, H.J., 2016. Vaccine trust and the limits of information. Science (New York, N.Y.) 353, 1207-1208.

Levine, P., 2017. Eugenics : a very short introduction.

Martin, D.C., 2003. Wilderness of Mirrors: Intrigue, Deception, and the Secrets That Destroyed Two of the Cold War's Most Important Agents The Lyons Press London

McNeill, W.H., 1976. Plagues and People. Doubleday Garden City, NY, USA.

Michie, S., West, R., Campbell, R., Brown, J., Gainforth, H., 2014. ABC of Behaviour Change Theories Silverback Publishing London.

Mirowski, P., 1989. More heat than light : economics as social physics : physics as nature's economics. Cambridge University Press Cambridge.

Moalem, S., 2007. The Survival of the Sickest. HarperCollins London, UK.

Oliver, K., Kothari, A., Mays, N., 2019. The dark side of coproduction: do the costs outweigh the benefits for health research? Health Research Policy and Systems 17, 33.

Pedler, A., 1927. Going to the People. The Russian Narodniki in 1874-5. The Slavonic Review 6, 130-141.

Pepin, J., 2011. The Origin of AIDS. Cambrdige University Press Cambridge, UK.

Pfeiffer, D.U., Otte, M.J., Roland-Holst, D., Zilberman, D., 2013. A one health perspective on HPAI H5N1 in the Greater Mekong sub-region. Comparative Immunology, Microbiology and Infectious Diseases 36, 309-319.

Piketty, T., 2014. Capital in the twenty-first century. The Belknap Press of Harvard University Press Cambridge Massachusetts.

Polanyi, K., 1957. The great transformation. Beacon Press Boston [Mass.

Pollock, A., 2019. Synthesizing Hope: matter, knowledge, and place in South African drug discovery. The University of Chicago Press Chicago and London.

Popper, K.R., 2002. The logic of scientific discovery. Routledge London ;.

Rovelli, C., 2015. Seven brief lessons on physics. Allen Lane London.

Scheffer, M., 2009. Critical Transitions in Nature and Society. Princeton University Press Princeton, NJ, USA; Woodstock, Oxfordshire, UK.

Scheffer, M., 2010. Complex systems: Foreseeing tipping points. Nature 467, 411-412.

Scheffer, M., Bascompte, J., Brock, W.A., Brovkin, V., Carpenter, S.R., Dakos, V., Held, H., van Nes, E.H., Rietkerk, M., Sugihara, G., 2009. Early-warning signals for critical transitions. Nature 461, 53-59.

Scott, J.C., 2017. Against the Grain. Yale University Press New Haven and London.

Spicker, S.F., 1987. An introduction to the medical epistemology of Georges Canguilhem: moving beyond Michel Foucault. The J. of Medicine and Philosophy 12, 397-411.

Strauss, C., 2006. The Imaginary. Anthropological Theory 6, 322-344.

Swartz, D., 1997. Culture & power : the sociology of Pierre Bourdieu. University of Chicago Press Chicago ;.

Taplin, D.H., Clark, H., 2012. Theory of Change Basics:a primer on theory of change. In: ActKnowledge (Ed.) ActKnowledge, 365 Fifth Avenue, 6th Floor, New York ,NY10016.

Tribe, M., 2010. Economics and Development Studies. Taylor and Francis Florence.

Wallace, R.G., 2009. Breeding Influenza: The Political Virology of Offshore Farming. Antipode 41, 916-951.

Wallace, R.G., Bergmann, L., Hogerwerf, L., Gilbert, M., 2010. Are Influenzas in Southern China Byproducts of the Region's Globalizing Historical Present? In: Giles-Vernick, T.a.C., S. with Gunn, J.L. (Ed.), Influenza and Public Health: learning from past pandemics. Earthscan, London.

Wallace, R.G., Bergmann, L., Kock, R., Gilbert, M., Hogerwerf, L., Wallace, R., Holmberg, M., 2015. The dawn of Structural One Health: A new science tracking disease emergence along circuits of capital. Social Science & Medicine 129, 68-77.

Weber, M., Parsons, T., 1947. The theory of social and economic organization. Free Press Glencoe, Ill.

Wittman, D.A., Weingast, B.R., 2008. The Oxford Handbook of Political Economy. Oxford University Press.

Wolfe ND, Dunavan CP, J., D., 2012. Origins of Major Human Infectious Diseases. National Academies Press (US); 2012. A16. Available from:. Institute of Medicine (US), Washington (DC): .

Zimmerman, J., 2015. Hermeneutics: A Very Short Introduction. Oxford University Press Oxford, UK.