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Book review

Rob Inkpen, Review of "Science, Philosophy and Physical Geography", Routledge, London, United Kingdom, 2005, 164 pp., ISBN 0-415-27954-2. Price 19.99 GBP (ca. 29 Euro, ca. 38 US$)

There are many books on writing and presenting about results of scientific research, but books on how to do earth scientific research are rare. Inkpen presents a practical and accessible book on the nature and practice of earth sciences which is also suitable for teaching. Although the title suggests a focus on physical geography, the book is appropriate to many, if not all, earth sciences. Philosophy of science is not reviewed in its own right. Rather, the earth-scientific themes and examples are well embedded in the old, well-known philosophical issues but also modern, less well-known ones that touch the fundaments and the practice of earth science.

The book starts off with historical themes in earth sciences: stability and change in the physical environment, the search for universal explanations, and the primacy of empirical information in earth science. Following these themes the reader is introduced to uniformitarianism versus catastrophism, Darwinian evolution, time scales of geomorphological change, the applicability of laws of physics, and also to the paradigms of Kuhn and the research programmes of Lakatos.

The second chapter is on how we may view reality. The well-known falsificationism of Karl Popper is contrasted with the verificationism of the logical positivists. If we accept falsificationism, then theories can only be disproven, which means that we can only know what reality is not. But is this what earth scientists do in testing hypotheses? The discussion reveals a much less simple but more realistic picture of practice.

The third chapter is on the nature of entities ('the things under study') and how we classify these. When case studies are used for generalisation, the entities in the case become exemplars for their kind. Three clear case studies are developed as examples for the abstract discussion. One is about species, one is about the relation between frequency and magnitude of events and their effect on (morphological) change, and one is on the classification of soils.

Several common forms of explanation are in use to link cause and effect. Building on this theme, the fourth chapter logically falls in line with the previous two. The reasoning may be deductive or inductive, or abductive. Victor Baker has drawn attention to this third style of reasoning for decades now, but its existence is not common knowledge while it is used by earth scientists at least as much as deduction and induction. An abduction is the construction of a theory from various pieces of evidence, also called 'smoking guns,' in the manner of Sherlock Holmes (although he erroneously tells Watson that it is deduction!). For example, the theory of the KT-impact is built on observations on iridium-rich clay layers in connection to a global extinction event, shocked quartz particles and, recently discovered, a buried impact crater of the right age on Yucatan, Mexico, and so on. These smoking guns are inferred to be caused by the impact of a comet or meteorite. We cannot deduce this, because we do not know the initial position of the comet relative to Earth although we know the Newtonian laws necessary to describe its orbit. This is indeed what earth sciences is partly about: inferring past conditions from the traces we find now. But another part is on present-day processes, and the plausibility of cause-and-effect relationships may also involve the intervention of researchers in reality.

How this intervention works in various practices is elaborated in the fifth chapter. Subjectivity and theory-ladenness of observations are a familiar problem in studies of phenomena that are difficult to

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measure quantitatively, but may also be problematic when quantification is not difficult. The problem of upscaling and applying physically based work on, for example, turbulence, to larger scale phenomena such as fluvial bed forms is illustrative. Triangulation of different observations and measurements of one phenomenon leads to more confidence in the reality, description or explanation of that phenomenon. A discussion of (laboratory) experimentation, the exemplar of intervention, is wanting, unfortunately.

Systems analysis (sixth chapter) is a relatively young approach aimed at unifying different entities and relations in one analytical framework. It has been applied to climate and oceans, ecosystems, landscapes and the coupling between these and other subsystems, which have demonstrated extensive sets of dependencies and feedbacks. It is also a fashionable approach, from which many terms, such as 'relaxation', have been borrowed and redefined in different contexts. This makes the testing of theories containing these terms problematic.

Moving on into change and complexity in chapter seven is again a logical step. Equilibrium, for example, of morphology, implies not only a balance but also the maintenance of that condition, for example, by means of negative feedbacks. Chaotic phenomena, on the other hand, are extremely sensitive to their initial or boundary conditions and apt to change in an unpredictable manner. The frequently misused terms complexity, non-linearity, self-organisation and so on are clarified and discussed, as well as their testability. The issue of emergence of phenomena at a large scale which are not predictable from the phenomena at smaller scales ties in neatly with the chapters on explanation and reality. The closely related theme of whether the laws of physics are sufficient to explain all phenomena at all scales could be developed better in this chapter, although it is still heavily debated in philosophy of science.

The final chapter is a somewhat shallow collection of reflections on the position of physical geographers in society, the connections and differences with human geography, and ethics.

Inkpen has written an accessible book on questions common to most earth sciences. More importantly, the embedding in philosophy of science is done well (as far as the reviewer can judge this) and unbiased and is enlightening to read. Many faculties of natural science, such as physics, chemistry, biology, have courses in the basics and philosophy of their science, but for earth sciences this is rare. Reasons for this unfortunate situation may be the interdisciplinary nature of earth sciences, the wealth of approaches that are not well covered by texts on other sciences, and the regrettable lack of suitable textbooks until now. The references to philosophical literature and the index could easily be improved, though, and Inkpen would do well to extend this book, and its title, to more earth sciences. In conclusion, this book is well worth reading for earth scientists and students.

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