



The significance of Gilbert F. White's 1945 paper 'Human adjustment to floods' in the development of risk and hazard management

N. Macdonald

University of Liverpool, UK

D. Chester

University of Liverpool, UK

H. Sangster

University of Liverpool, UK

B. Todd

University of Liverpool, UK

J. Hooke

University of Liverpool, UK

Abstract

Few publications may claim to have transcended the original field in which they were written, by shaping a wide range of research areas and philosophies. In this short paper we reflect on the manner in which Gilbert F. White's 1945 publication 'Human adjustment to floods' has not only shaped how we study and perceive flooding, but has also had a significance beyond its original aims, revolutionizing the ways in which hazard and risk are conceptualized more generally. Before considering the impact of 'Human adjustment to floods', we briefly review academic understanding of floods in the decades leading up to the 1940s and later place the 1945 paper in the context of White's subsequent contributions to research which both developed and built on his ideas.

Keywords

flood management, Gilbert F. White, hazard, risk

1 Introduction

Floods are 'acts of God,' but flood losses are largely acts of man. (White, 1945: 2)

An increased awareness of climatic variability (Solomon et al., 2007) and an anticipated increase in future floods have stimulated much discussion over hazard, risk and disaster management

(Werritty, 2006). Within the context of an increasing awareness and concern over flooding

Corresponding author:

N. Macdonald, School of Environmental Sciences, Roxby Building, University of Liverpool, Liverpool L69 7ZT, UK
Email: neil.macdonald@liverpool.ac.uk

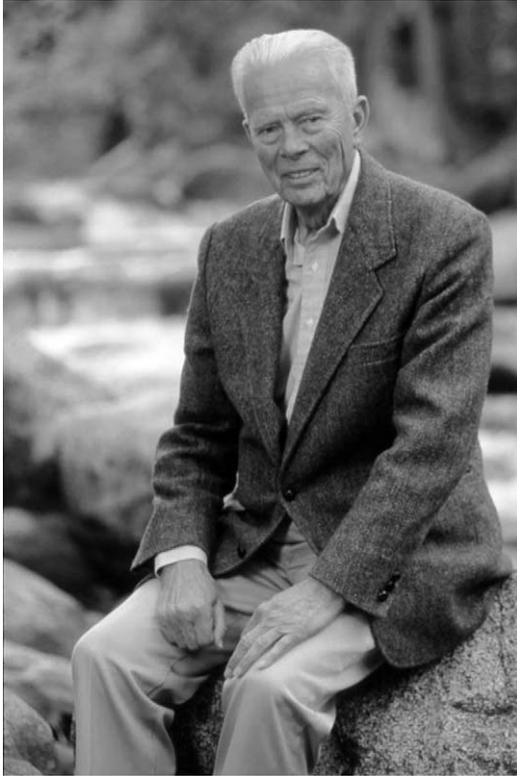


Figure 1. Gilbert F. White

Source: With permission from the University of Colorado at Boulder (UCB), University Archives, Office of Publication and Creative Services Collection, image number 501704.

and its impact, revisiting the research of Gilbert White (Figure 1) – a person who has been rightly described as ‘father of floodplain management’ (Kates and Burton, 2008: 481) – is highly pertinent.

This is especially relevant because extensive flooding within the last decade has occurred throughout Europe and has included events which have caused loss of life and considerable damage. For example: those in March 2001 in Hungary and the Ukraine (Szlávik, 2003); August 2002 in central Europe (Kundzewicz et al., 1999; Ulbrich et al., 2003); July 2005 and August 2007 in Switzerland (Bezzola and Hegg, 2007; Schmutz et al., 2008); and October/November 2000, July 2007 and November 2009 in England and Wales (Marsh and Hannaford, 2007; Sibley, 2010).

Gilbert White’s research cannot be simply arranged into a chronological sequence showing development over time, but is more complex, involving a flow of ideas through which a number of separate yet related themes can be determined (Kates and Burton, 1986). For example, although Gilbert White is most closely associated with flooding and water resource issues, a considerable portion of his career was spent studying other types of hazard and wider environmental issues, which included, in particular, arid landscapes (Wescoat, 2006). In revisiting White’s initial work on floods we reflect on developments over the past six decades and consider whether these either challenge White’s attitudes to flood risk management in particular, and natural hazard risk more generally, or alternatively, if the lessons learnt in the early 1940s remain relevant today.

Understanding the impact of White’s (1945) ‘Human adjustment to floods’, which began life as a University of Chicago PhD in 1942, requires a consideration of both its motivation, and philosophical and political contexts. In the USA, the late 1920s and 1930s were notable for a series of environmental extremes, which ranged from the Mississippi flood of 1927 (Barry, 1998) to severe droughts in the 1930s, most notably in 1934 (Hurt, 1981). Within this framework of environmental catastrophes and subsequent social hardship, the latter being not only a consequence of the extreme physical processes but also of the Great Depression, a new approach to managing the environment emerged. In order to deal with the Great Depression, government policy became more interventionist and involved a series of policies that became known as President Roosevelt’s New Deal (Reisner, 1993). This change in political philosophy altered the ways in which many individual scientists/engineers and governmental bodies viewed their responsibilities, being concerned not just with studying environmental processes per se, but with applying this knowledge to the development of policies of hazard reduction. In

the 1930s President Roosevelt signed bills establishing several environmental agencies – most notably the Soil Conservation Service – but until the early 1940s flood defence remained largely an individual's responsibility, there being little consideration of management practices geared to either risk reduction or increasing social and economic resilience at national and/or regional levels (I. White, 2008). On the Mississippi, America's largest and most regulated river, for example, the only major intervention was under the control of US Army Corps of Engineers who remained firmly wedded to a policy of flood control involving the construction of levees and other engineering works. This was despite the fact that a disastrous levee failure during the 1927 flood had been a major factor contributing to the catastrophic damage inflicted on the people living on the floodplain (Burton, 2008; Hinshaw, 2006: xiii). Changes in political and social awareness caused a shift in perspective, and White's 'Human adjustment to floods' played a key role in redefining how hazards and human responses should be studied.

II Philosophical structure

Gilbert White was strongly influenced by American pragmatism, and especially by the work of John Dewey (Wescoat, 1992). Dewey's philosophy may be summarized under four headings:

- (1) the precariousness of human life;
- (2) learning from experience;
- (3) a pragmatic notion of science;
- (4) open discourse within a democratic framework.

There are both philosophical commonalities and differences between Dewey and White, and the degree to which the former influenced the latter has been debated (see Wescoat, 1992). There seems little doubt, however, that White was greatly influenced by a combination of the interventionist political climate of the time, the

ideas of Dewey which were prominent in the University of Chicago and not least by his Quaker faith, which placed great store in working to benefit society and making a positive contribution to human betterment (Hinshaw, 2006). In considering these influences, a brief biography of White illustrates how these key themes run throughout not only his academic work, but also his actions as a committed Quaker. As a conscientious objector to the Second World War he served with the American Friends Service Committee aiding refugees of the war in France, and was briefly interned at Baden-Baden by the Germans (Kates, 2011). On returning to the USA he became President at Haverford College (1946–1955) and subsequently moved to the University of Chicago (1956–1969), where he and colleagues pioneered the integration of the study of human behaviour and extreme natural events (latterly known as the 'Chicago School' of natural hazard research), this work has subsequently been developed by a number of authors (see Burton et al., 1993). White moved to the University of Colorado (1970–2006), where he was the founder and director of the Natural Hazards Center. Throughout this time White served as a leader in various Quaker service organizations.

All three influences, interventionist political climate, influence of Dewey, and Quaker faith, emerged in inchoate form in one of White's earliest papers on the economic justification for flood protection (White, 1936), but it is in 'Human adjustment to floods' (White, 1945) that his ideas are developed in detail. The key to understanding 'Human adjustments' comes right at the beginning when White (1945: 2) writes: 'floods are acts of God, but flood losses are largely acts of man [sic]. Human encroachment upon floodplains of rivers accounts for the high annual total of flood losses.' White then progresses in five closely argued chapters to develop both an original perspective on flooding in the USA and to provide ideas that were subsequently developed into a framework that allowed the study of a wide variety of hazards,

not only in North America, but also in other parts of the world. The first chapter reviews the problem of flooding in the USA, and in Chapter 2 White introduces the term 'adjustment' by spelling out the ways in which people may react to flooding. These 'adjustments' are:

- land elevation;
- flood abatement (i.e. land-management upstream);
- flood protection (e.g. engineering solutions involving inter alia the use of levees, channel improvements, cutoffs and floodways);
- emergency measures (e.g. the temporary protection of property and persons);
- structural arrangements to physical structures such as roads and buildings;
- land-use changes;
- public relief and insurance.

In subsequent chapters the major factors affecting the choice of adjustment are explored in detail, and White argues that a sound approach to flooding 'will take account of all possible adjustments which might be made to the flood hazard' (p. 206). He concludes that a comprehensive policy using a wide variety of adjustments is required. Under present 'legislative directives the Federal government's concern with reducing flood losses is limited to flood protection, flood abatement by land management, certain types of emergency measures, public relief, and the relocation of a community if it can be accomplished at a cost less than that of protection' (p. 210).

III The legacy of 'Human adjustment to floods'

The long-term legacy is evident in three research fields: flood studies; hazard and risk management; environmentalism and climate change.

I Flooding

It is notable that both White's 1936 paper 'The limit of economic justification for flood

protection' and 'Human adjustment to floods' (1945) tell us much about how flood mitigation and management have been conceptualized during the past 70 years. Indeed many of White's concepts about different forms of adjustment may be seen to have been prophetic, and have only recently been incorporated into public policy. The UK Institutions of Civil Engineers publication, 'Learning to live with rivers' (ICE, 2001) and the European Union's Water Framework Directive (EC, 2000), in which there is both greater acceptance of hydrological variability and a movement away from the 'Victorian' convention of assuming that engineering is a panacea for solving all flood management problems, are both examples of the lasting impact of White's early research. In the words of Alan Werritty (2006: 21), 'a centralized technocratic paradigm with structural solutions providing the most favoured option has, until recently, underpinned ... flood defence policy'. Within the context of climate change, the sole application of engineering solutions is, however, increasingly being viewed as severely constraining a move towards more holistic catchment-wise management plans, and this is further encouraged in Europe by Catchment Management Plans, which are an integral part of the European Union's Water Framework Directive (EC, 2000). Within Europe, greater acceptance of Gilbert White's ideas may also be seen within schemes of coastal managed realignment and their supporting legislation (ICE, 2010), which show a greater appreciation of natural variability and cost-benefit analysis applied to alternative forms of adjustment, a methodology which was, indeed, pioneered in White's 1936 paper.

When considering the role of White's 1945 publication, one of the challenges is that of direct or diffuse learning; reports published over the last decade rarely directly reference White's initial work, yet reference subsequent works by individuals whose own research has been heavily shaped by White's. Attempting to construct a citation history of White's 1945 work is

fraught with difficulties, as much of the influential material appears as ‘grey literature’, and is not identified within current academic search engines. A disciplinary divide between geographers and engineers may in part explain why it has taken so long for this work to permeate through to policy. The lessons of the 1945 paper were readily accepted and appreciated by Geographers (e.g. Cooke and Doornkamp, 1974), while the uptake within the engineering community has been slower – for example, The UK Flood Studies Report (Institute of Hydrology, 1975) fails to mention any of White’s work. It is possible that the recent uptake by engineers reflects an increasing recognition that the conventional engineering approaches alone are insufficient in flood management and mitigation.

Although White’s 1945 publication has received greater recognition, many of his ideas currently being adopted first appeared in outline form in his earlier paper (White, 1936), where the value of standardized cost-benefit analysis in flood management was discussed together with a requirement not only for consistent and clear public policy in relation to where and how flood management should be focused, but also for non-economic social and environment benefits to be incorporated into any evaluation. Gilbert White also called for the evaluation of completed projects to consider whether they had achieved their goals, the planned environmental and social benefits, and to determine if negative impacts had occurred. In the 1940s and given the predominant engineering focus in most flood management schemes, the absence of project evaluation was notable and has only been effectively implemented widely during recent decades. Understanding the engineering impacts on fluvial systems is challenging, and Jähnig et al. (2009) argue that even today evaluating the impact of construction on ecological systems remains poorly understood and that this makes future assessments of design impact extremely difficult.

2 Hazard and risk management

Gilbert White’s impact on studies of hazard was so profound that by the end of the 1970s his methodology was widely known as the ‘dominant’ approach. Building upon ideas present in his 1945 publication, particularly ‘adjustment’ (Mitchell, 2008), White worked with like-minded academics including Robert Kates and Ian Burton, and developed a series of techniques that were used to study not only flooding in the USA, but also the totality of natural hazards in the world. This became the commanding influence on the research literature, which in turn shaped the approaches to hazard reduction policies as framed by national governments. The characteristics of the dominant approach are complex in detail (see Alexander, 2000: 23–53; Chester, 2005: 415–421), but briefly, while accepting that factors of wealth, systems of belief, experience of previous hazardous events and psychological factors have profound influences on human responses to disasters, White and his colleagues focused on the notion that there exists a range of adjustments to natural hazards, which are available to individuals and/or societies when they have to cope with extreme natural events; with new adjustments potentially either being short-lived, or over time becoming an integral part of the adoptive fabric of the culture (Burton et al., 1993).

Until the 1980s, academic writers, national governments and international agencies were strongly committed to policies of loss reduction, which were strongly grounded in the dominant paradigm in general, and in particular in selecting the most appropriate combination of adjustments in order to cope with a hazard threat. Nearly 30 years ago, Kenneth Hewitt (1983), however, edited a volume, *Interpretations of Calamity*, which ushered in a period during which White’s dominant approach was severely criticized by a group of scholars who became known as the

‘radical critics’. Basing their research on studies of long-onset disasters, particularly droughts in poor countries, they argued that most disasters are principally the result of marginalization, poverty and deprivation, rather than extreme meteorological and geophysical conditions *per se*.

The decade of the 1990s was designated by the United Nations as the International Decade for Natural Disaster Reduction (IDNDR), while the period since 2001 has seen the development of the UN’s International Strategy for Disaster Reduction (ISDR). As argued elsewhere (Chester, 2005; Chester and Duncan, 2010), the whole tenor of research is now more focused on the uniqueness of place, not only in terms of meteorological and geophysical threats, but also in terms of the particular society and culture at risk, hazard reduction involving a boosting of resilience and a reduction in human vulnerability. While poverty and marginalization are important considerations in understanding hazardousness, this has not replaced, but has merely supplemented, the notion of adjustment that was first aired by Gilbert White some seven decades ago.

3 Environmentalism

White’s role in shaping environmentalism during the 20th century is more diffuse than within other fields, in part reflecting the breadth of interest and research undertaken throughout his career. In considering the importance of his work in the environmentalism field we only need look at how White’s work shaped environmental policy not just in the USA, but also as far afield as Africa, particularly in water resource management (White, 2000). Much of the work undertaken in the 1970s and 1980s by White focused on the challenges of water resource provision (White, 1974; White et al., 1972), an issue within almost all climatic zones, economically more developed and economically less developed countries, and in all types of political,

economic and social systems; with a range of societal and technological approaches to adjustment and response.

IV Conclusion: wider environmental issues

According to James Mitchell (2008: 451) ‘for White, choice is the central existential dilemma: how do humans select a course of action in an ambient world replete with risks and opportunities that are incompletely known?’ and this is a central thread that runs through much of his research, being first developed as the concept of adjustment in his PhD thesis (White, 1942) and being present in his later work on flooding and global hazards. In research outside these areas, this notion of selection/adjustment is combined with White’s Quaker-influenced desire for human betterment and is expressed in four research themes: domestic water supply; the encouragement of global and regional peace through adjustments, which allow potentially conflicting interests and peoples to manage water resources effectively; the application of science in general and geography in particular, beyond the academy to the practical service of humankind; and the use of resources to achieve sustainable development (Kates and Burton, 2008: 480). These research themes are summarized in Table 1.

Perhaps the most eloquent conclusion to White’s impact and challenge to geographers comes in his own words: ‘what shall it profit a profession if it fabricates a nifty discipline about the world while that world and the human spirit are degraded?’ (White, 1972, quoted by Burton, 2008: 449).

Acknowledgements

The image of Gilbert F. White is used with permission from the University of Colorado at Boulder (UCB). The constructive and thoughtful comments of an anonymous reviewer helped to improve the paper and are gratefully acknowledged.

Table 1. Notions of choice/adjustment and human betterment in some research areas addressed by Gilbert White (based on the references cited and information in Kates and Burton, 2008, with additions and amendments)

Research theme	Details
Water supply	White's first paper was on water shortages in the USA (White, 1935) and subsequently he was concerned with industrial use and misuse both in America and internationally where he worked with UNESCO. White's most notable contribution, however, was a joint study with his wife and the epidemiologist David Bradley in East Africa (White et al., 1972). The researched team focused on making appropriate adjustments, so that waterborne disease was reduced. He viewed access to water not just as an economic good but as a human right (White, 1974), and this thinking greatly influenced both the UN's International Drinking Water and Sanitation Decade in the 1980s and their Millennium Development Goal to reduce by half the people who have no access to safe water.
Promoting peace through water resource development and basin management	'The leitmotiv of Gilbert White's life and his highest aspiration to make a difference was in the realm of peace' (Kates and Burton, 2008: 482). This commitment may be seen in a wide range of research projects including: advising on water resource development along the Mekong River in Vietnam to alleviate poverty rather than merely just construct dams (White, 1963, 1964); and his chairing a committee on sustainable water supplies in the Middle East (CSWS, 1999: xi).
The application of science beyond the academy	Gilbert White strongly promoted this goal of applied science when he achieved the status of a senior academic; for example, in his capacity as President of the Association of American Geographers in 1961 (White, 1962: 279; 1972) and as a member of the United States National Academy of Science to which he was elected in 1973.
Resources and sustainable development	In addition to notions of selection/adjustment and betterment, White is also known for a 'search for harmony and reconciliation' not just within the environment but between the environment and human society (Kates and Burton, 2008: 484), and this influence may be seen in both contemporary research on human-induced global environmental change, and in the acceptance of his vision of dealing with uncertainty and seeking public good in contemporary research fields which are focused on sustainability (see Kates et al., 2001).

References

- Alexander D (2000) *Confronting catastrophe*. Harpenden: Terra Publications, 282 pp.
- Barry JM (1998) *Rising Tide: The Great Mississippi Flood of 1927 and How it Changed America*. London: Simon and Schuster, 528 pp.
- Bezzola GR and Hegg C (eds) (2007) *Ereignisanalyse Hochwasser 2005, Teil 1 – Prozesse, Schäden und erste Einordnung*. Bundesamt für Umwelt BAFU, Eidgenössische Forschungsanstalt WSL. Umwelt Wissen Nr. 0707, 215 pp.
- Burton I (2008) Gilbert White: Progress in geography. *Progress in Human Geography* 32: 448–450.
- Burton I, Kates RW, and White GF (1993) *The Environment as Hazard*, second edition. London: Guilford Press, 290 pp.
- Chester DK (2005) Volcanoes, society and culture. In: Marti J and Ernst GJ (eds) *Volcanoes and the Environment*. Cambridge: Cambridge University Press, 404–439.
- Chester DK and Duncan AM (2010) Coping with disasters within the Christian tradition, with reference to volcanic eruptions and earthquakes. *Religion* 40: 85–95.
- Committee on Sustainable Water Supplies (CSWS) (1999) *Water for the Future: The West Bank and Gaza Strip, Israel and Jordan*. Washington, DC: Committee on Sustainable Water Supplies in the Middle East, National Academy Press.
- Cooke RU and Doornkamp JC (1974) *Geomorphology in Environmental Management: An Introduction*. Oxford: Clarendon Press.
- European Commission (EC) (2000) EU Water Framework Directive. 2000/60/EC.
- Hewitt K (1983) *Interpretations of Calamity*. London: Allen and Unwin, 304 pp.
- Hinshaw RE (2006) *Living with Nature's Extremes: The Life of Gilbert Fowler White*. Boulder, CO: Johnson Books, 339 pp.
- Hurt DR (1981) *An Agricultural and Social History of the Dust Bowl*. Chicago: Nelson Hall, 214 pp.
- Institution of Civil Engineers (ICE) (2001) Learning to live with rivers. London: ICE. Available at: <http://www.ice.org.uk/Information-resources/Document-Library/Learning-to-live-with-rivers>.
- Institution of Civil Engineers (ICE) (2010) Facing up to rising sea levels. London: ICE. Available at: <http://www.ice.org.uk/Information-resources/Document-Library/Facing-up-to-rising-sea-levels>.
- Institute of Hydrology (1975) *Flood Studies Report*. Wallingford: Institute of Hydrology.
- Jähnig SC, Lorenz AW, and Hering D (2009) Restoration effort, habitat mosaics, and macroinvertebrates – does channel form determine community composition? *Aquatic Conservation* 9: 157–169.
- Kates RW (2011) *Gilbert F. White 1911–2006: A Biographical Memoir by Robert W. Kates*. Washington, DC: National Academy of Sciences. Available at: http://www.nasonline.org/site/DocServer/White_Gilbert.pdf?docID=74341.
- Kates RW and Burton I (1986) *Geography Resources and Environment* (two volumes). Chicago: University of Chicago Press.
- Kates RW and Burton I (2008) Gilbert F. White, 1911–2006: Local legacies, national achievements and global visions. *Annals of the Association of American Geographers* 98: 479–486.
- Kates RW, Clark WC, Corell R, Hall JM, Jaeger CA, Lowe I, et al. (2001) Sustainability science. *Science* 292: 641–642.
- Kundzewicz ZW, Szamalek K, and Kowalczyk P (1999) The great flood of 1997 in Poland. *Hydrological Science Journal* 24: 855–870.
- Marsh TJ and Hannaford J (2007) *The Summer 2007 Floods in England and Wales – A Hydrological Appraisal*. Wallingford: Centre for Ecology and Hydrology, 32 pp.
- Mitchell JK (2008) Perspectives on alternatives: Differentiation and integration in pursuit of a better fit between society and nature. *Progress in Human Geography* 32: 451–458.
- Reisner M (1993) *Cadillac Desert: The American West and its Disappearing Water*. London: Penguin, 608 pp.
- Schmutz C, Arpagaus M, Clementi L, Frei C, Fukutome S, Germann U, et al. (2008) *Ereignisanalyse Hochwasser 8. bis 9. August 2007 – Beitrag der MeteoSchweiz*. Arbeitsberichte der MeteoSchweiz 222. Zurich: MeteoSchweiz, 30 pp.
- Sibley A (2010) Analysis of extreme rainfall and flooding in Cumbria 18–20 November 2009. *Weather* 65: 287–292.
- Solomon S, Qin D, Manning M, Marquis M, Averyt K, Tignor MMB, et al. (eds) (2007) *Climate Change: The Physical Science Basis*. Cambridge: Cambridge University Press, 996 pp.
- Szlávik L (ed.) (2003) Az 1998 évi árvíz ('Flood of the year 1998'). *Vízügyi Közlemények* 85(1), Special Issue, 216 pp.
- Ulbrich U, Brücher T, Fink AH, Leckebusch GC, Krüger A, and Pinto JG (2003) The central European floods

- of August 2002: Part 1 – Rainfall periods and flood development. *Weather* 58: 371–377.
- Werritty A (2006) Sustainable flood management: Oxymoron or new paradigm? *Area* 38: 16–23.
- Wescoat JL (1992) Common themes in the work of Gilbert White and John Dewey: A pragmatic appraisal. *Annals of the Association of American Geographers* 82: 587–607.
- Wescoat JL (2006) Gilbert Fowler White (1911–2006), wisdom in environmental geography. *Geographical Review* 96: 700–710.
- White GF (1935) Shortage of public water supplies in the United States during 1934. *Journal of the American Water Works Association* 27: 841–855.
- White GF (1936) The limit of economic justification for flood protection. *The Journal of Land and Public Utility Economics* 12: 133–148.
- White GF (1942) Human adjustments to floods. Unpublished PhD, Department of Geography, University of Chicago.
- White GF (1945) Human adjustment to floods. Research Paper 29. Department of Geography, University of Chicago, 225 pp.
- White GF (1962) Critical issues concerning geography in the public service – introduction. *Annals of the Association of American Geography* 52: 279–280.
- White GF (1963) The Mekong River plan. *Scientific American* 208: 49–59.
- White GF (1964) Vietnam: The fourth course. *Bulletin of the Atomic Scientists* 20: 6–10.
- White GF (1972) Geography and public policy. *The Professional Geographer* 24: 101–104.
- White GF (1974) Domestic water supply: Right or good. In: *Proceedings of Ciba Foundation Symposium on Human Rights in Health* 4–6 July. Amsterdam: Associated Scientific Publishers, 35–59.
- White GF (2000) Water science and technology. *Environment* 42: 30–38.
- White GF, Bradley DJ, and White AU (1972) *Drawers of Water: Domestic Water Use in East Africa*. Chicago: University of Chicago Press, 318 pp.
- White I (2008) The absorbent city: Urban form and flood risk management. *Proceedings of the ICE – Urban Design and Planning* 4: 151–161.