and drivers of the Earth system to Atlantic circulation and hence to the risk of extreme rainfall in the UK. Many of these drivers appear to have been contributing to a large-scale synoptic situation conducive to flooding in the UK in DJF1314. We remain confident that improved modelling of such drivers will improve our ability to interpret and predict both long-term and year-to-year variations in flood risk. However, we are particularly careful in our Perspective article not to attribute DJF1314 rainfall events to any specific driver. Instead, the purpose of our study was to highlight that it is important to correctly model known teleconnections to Atlantic circulation if we are to understand and predict changing flood risks. That said, as van Oldenborgh *et al.*[2] correctly note, an ability to predict flood risk should not be confused with capability to predict individual flood events: the enormous importance of chance should always be acknowledged in any discussion of our chaotic weather. ❐

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# Tidal river management in Bangladesh

**To the Editor** — The study by Auerbach *et al.*[1] advances understanding of the drivers of flood risk in natural and embanked regions of the coastal and tidal regions of Bangladesh. The quantification of sedimentation rates and how effectively periodic opening and closing of polders may result in elevation recovery is valuable in the context of reducing the vulnerability of coastal Bangladesh to flooding in the twenty-first century.

However, we are surprised at the authors' apparent lack of awareness of the long-practiced protocol called tidal river management (TRM) and its successful implementation for over a decade in coastal Bangladesh[2,3]. TRM involves the periodic cutting and closing of polders to accelerate land accretion (or reclamation). TRM as a concept has been around since the 1990s and has been practised or analysed by many local stakeholder entities such as the Institute of Water Modelling of Bangladesh for elevation recovery in several (embanked) regions in coastal Bangladesh. Thus, the management strategy advocated by Auerbach *et al.*[1] is not so innovative.

In summary, we commend the authors' quantitative work on understanding flood risk on embanked polder regions. However, the Letter could be more cognizant of previous studies and could have benefited by learning from local wisdom to potentially make their research more useful to the local stakeholders[4]. ❐

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## Reply to 'Tidal river management in Bangladesh'

**Auerbach *et al.* reply** — We appreciate the opportunity to address tidal river management (TRM), as raised by Hossain and colleagues[1]. We are aware of TRM but made the decision not to include it in our Letter[2] on flood risk on the Ganges-Brahmaputra tidal delta plain for the following reasons.

First, our Letter[2] concerns a major disaster that displaced >100,000 people and flooded an anthropogenically degraded landscape for nearly two years. These circumstances, and our finding that decimetres of sandy, saline sediment unsuitable for agriculture were deposited, do not lead to a simple endorsement of TRM.

Second, TRM presents neither a simple engineering solution nor one that is socially or politically straightforward. Beyond the TRM implementations noted by Hossain and colleagues[1], there have been well-documented failures resulting from both engineering challenges[3] and lack of proper social discourse[4]. Although these occurrences do not discount the potential benefits of TRM[5–7], they do preclude an unqualified prescription in the context of our Letter.

Third, sites where TRM has been used lie >50 km inland of Polder 32 — where the physical environment is considerably different, with reduced tidal energy and less saline surface waters. Furthermore, the area of TRM test sites is about a third of the size of Polder 32, and together these areas comprise <1% of the 5,000 km$^2$ of southwest Bangladesh. Thus to consider the application of TRM across the region is premature.

We regret any misperception that we sought to proclaim a 'new' or 'innovative' approach. In hindsight, it would have been appropriate to cite relevant TRM literature in our Letter, and we are thankful to do so here. However, given the region's non-uniform social and physical landscapes and the relatively limited application of TRM to date, the results of our study cannot provide direct support for TRM as a comprehensive management strategy. This should not discount continued development of the practice or exploration of its potential benefits. ❐

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# Opening up the black box of adaptation decision-making

**To the Editor** — Although the recent Perspective by Eisenack *et. al.*[1] attempts to move the discussion on barriers to climate change adaptation forwards, in our view it still does not address a key challenge that has hampered this line of research since its beginnings. In 2007, the Fourth Assessment Report of the IPCC stated that adaptation efforts will encounter — and hence need to overcome — different types of limits, constraints or barriers[2]. Since then, the scientific community has busily identified and catalogued all manner of different barriers, and discussed various means of overcoming them. While offering an important first step in exploring adaptation, the tendency to abide by top-down and functionalist views of decision-making and barriers is both problematic conceptually and unsupportable empirically if the ambition is to explain adaptation decision-making.

Much of the scholarly debate has implicitly followed the logic that since there is a 'gap' between the actual and expected output of adaptation decision-making, something must be preventing policymaking from attaining its true equilibrium. Hence the often ex ante identified barriers to adaptation required to explain this gap[1]. The key problem with this line of thinking is that it originates with the normative assumption that collective decision-making at national, regional, and local levels should be producing climate-adaptive decisions and actions. This highly linear and functionalist understanding of decision-making assumes that socio-political systems would be automatically adjusting to changes in the absence of barriers[3]. As a consequence of such a view, the complexities of collective decision-making on adaptation are reduced to simple input–output models in which important internal dynamics and processes are absent. This is what has often been referred to as a black box view on decision-making[4].

Categorizing any factor or process as a barrier reduces complex and highly dynamic decision-making processes into simplified, static and metaphorical statements about why current outcomes are 'incorrect'. Examples are omnipresent in the adaptation literature, in which blame for the failure of decision-making to address climate change risks is placed on such factors as lack of resources, lack of knowledge, or lack of will[5]. But explaining decision-making requires first and foremost identification of the suite of (plausible) causal processes that are responsible for producing a certain outcome or effect[6]. Barrier thinking, with its overly reductionist comprehension of the decision-making process, prevents such explanations.

Contemporary public policy and governance studies have long abandoned barrier thinking and instead treat decision-making processes as dynamically complex, contributing to an erratic pattern of decision-making that does not necessarily result in appropriate responses to policy drivers[7,8]. Of central concern are the iterative processes of social construction, problem framing and the intentional development of policy alternatives. Processes such as power struggles, misfortune, organized irresponsibility and social learning — as well as policy innovation and diffusion — are critical to policy outcomes[4,5,9], and thus also to our research frameworks, if they are to be realistic and robust.

Although we sympathize with the proposal by Eisenack *et al.*[1] to include feedback, causal interdependencies and agency — in other words to increase complexity — in climate change adaptation policy analysis, these proposals are of limited value if they remain rooted in barrier thinking. If the ambition is to explain rather than to describe how public policy can successfully address the challenges of climate change adaptation, the functionalist framework — and the associated concept of barriers — should be discarded altogether.

Alternatives are plentiful. In political sciences, for example, implementation research has moved away from notions of barriers to implementation as it became clear that the actions prescribed based on the identified barriers fail to solve the problems in practice. Contemporary third generation implementation studies now focus on a variety of top-down and bottom-up causes and processes for explaining the way decision-makers deal with given rules and norms in understanding how implementation processes work,