How does terrestrial land use affect coastal environments?

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1. Overview

Changes in land use alter fluxes of sediment and nutrients into coastal environments, including deltas and coastal wetlands. Changes in these fluxes can cause dramatic changes in the sizes and elevations of these environments, and therefore in the ecosystem services they provide.

2. Specific Recommendations

Despite considerable work documenting changes in sediment delivery (e.g. Syvitski et al., 2005; Fig. 1), and showing that shapes and sizes of present deltas and coastal marshes result from past land-use changes (e.g. Ashton et al., 2013; Kirwan et al., 2011), many relevant and scientifically timely questions should be addressed.

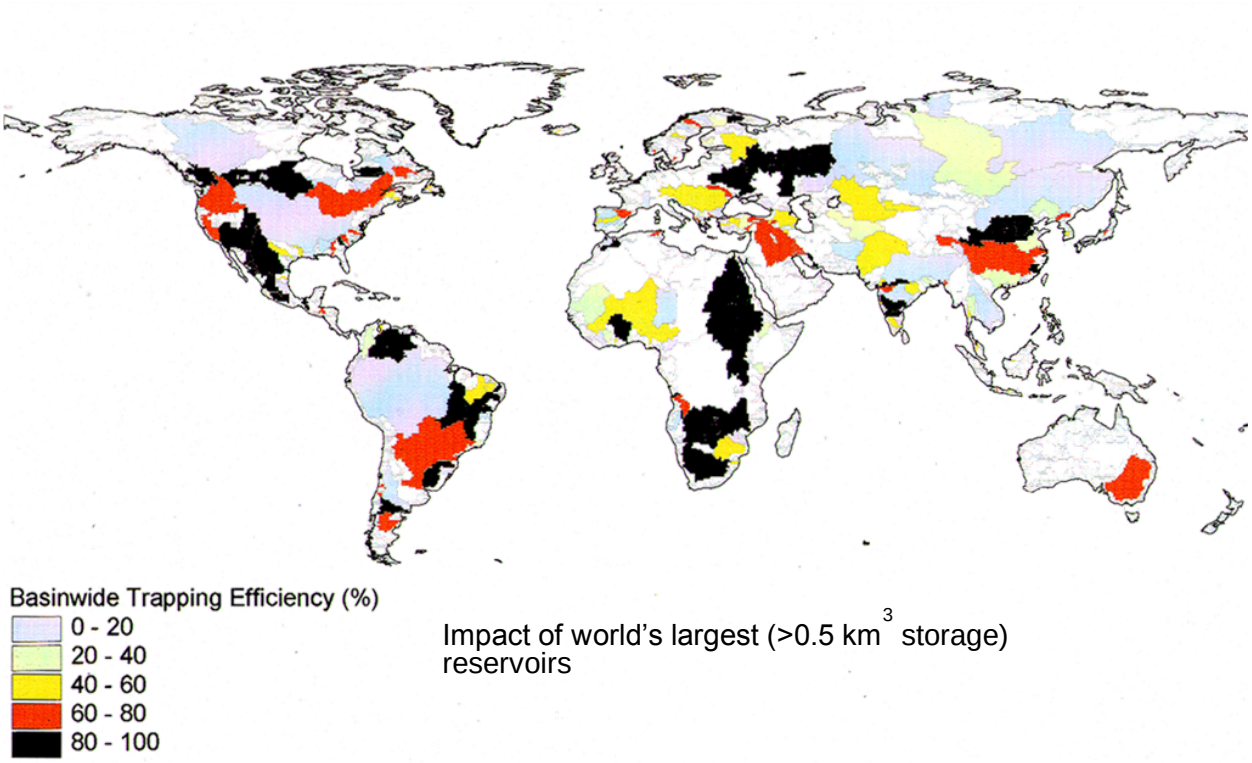

Figure 1. Reductions in sediment fluxes to coastal environments from major rivers. The basins and rivers shown here highlight the effects of dams trapping sediment. However, other forms of land use including development and reforestation also reduce sediment fluxes from many watersheds. In addition, earlier phases of development (involving initial construction) and deforestation (often related to agriculture), greatly increase sediment fluxes to coastal environments in some areas. After Syvitski et al., 2005.

For example: 1) How do changes in sediment delivery from terrestrial watersheds interact with human risk-reduction efforts on deltas, including flood control measures, and how do these interactions affect the loss of delta land? 2) How do changes in sediment delivery affect river-bed elevation, flood risks,

and likelihood of river avulsions? **Addressing broad questions such as these will require the development and coupling of numerical models of disparate environments and processes, including the human dynamics driving manipulations of delta processes (Mcnamara and Werner, 2007).** Model development and model coupling should make use of and contribute to the Community Surface Dynamics Modeling System (CSDMS; https://csdms.colorado.edu/wiki/Main_Page).

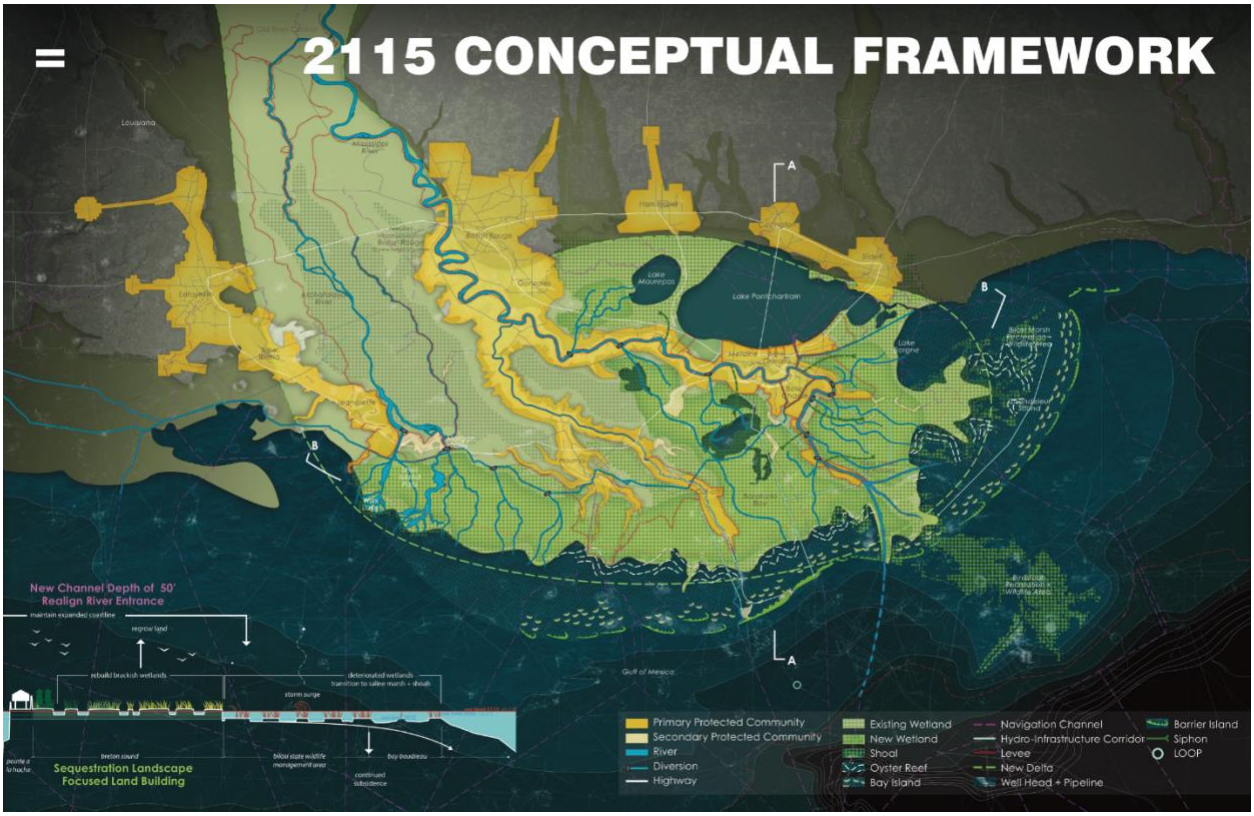

Figure 2. Schematic depiction of one of the plans Louisiana policy makers are considering as they develop the next iteration of the 'Master Plan' for the long-term (50-year) management of the Mississippi River Delta and associated landscapes and ecosystems. From MISI-ZIIBI Living Delta Proposal; http://changingcourse.us

Another set of questions involve the extensive coastal marshes along the Southeastern seaboard of North America. Recent research suggests that deforestation following European colonization, which lasted through the Civil War period, led to pronounced increases in the area of coastal marshes (Kir wan et al., 2011). However, this coastal impact of terrestrial land use has only been documented in one well-studied location (Plumb Island Sound Estuary, Massachusetts), and the suggestion that many extensive marshes on the Easter seaboard might be (in part) artifacts of post-colonial land use remains controversial. How widespread is this legacy of past land-use changes? Was the pulse of sediment resulting from deforestation sequestered in deposits in many watersheds before reaching the coast? A related question addresses the future of extensive coastal marshes. If they are partly legacies of past land use changes, and would not have become as extensive as they currently are under the present sediment delivery rates (following reforestation, development, and damming of watersheds), marshes may be metastable—prone to sudden loss of marsh area when disturbed. **Answering questions such as**

these requires field investigations of multiple watersheds and coastal wetlands, combined with numerical model development and targeted model experiments.

3. Impacts

Questions regarding the impacts terrestrial land-use changes have on coastal environments meld scientific timeliness with societal relevance. Deltas serve as habitation for many, as transportation and economic hubs, and they host rich and valued ecosystems. The state of Louisiana is developing plans for how to actively manage the future of the Mississippi River Delta—it's size, it's shape, and how and when sediment, fresh water and nutrients are delivered to different parts of the Delta (http://coastal.la.gov/our-plan/2017-coastal-master-plan/; http://changingcourse.us/about-us/abo-changing-course). Coastal marshes in many settings are ecologically rich and productive. They provide nurseries for many economically important fish species, and storm protection for communities. Assessing how deltas and wetlands have been shaped in the past—especially the role terrestrial land-use changes have played—will help us forecast future trajectories, and to manage their futures in more informed ways.

4. Reasoning and Evidence

The questions motivating these recommendations stem from recent research, and considerable societal deliberations, addressing how deltas may change in the future, and how that change can be managed (e.g. http://coastal.la.gov/our-plan/2017-coastal-master-plan/; REF Paola, Masterplan…), and recent research documenting the dramatic expansion of one well coastal marsh, apparently in response to terrestrial land-use changes (Kirwan et al., 2011), as well as initial investigation of how marsh extent relates to factors including land use on a broader scale (REF Anna).

References

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