Direct and Indirect Effects of Large-Scale Restoration and Implications for Science and Mgmt

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Delta Science Program

10-30-14

Emphasis on physical processes

1. Tidal energy drives estuary processes

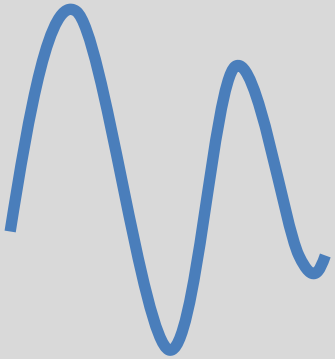
→ 2. Tidal range

→ 3. Tidal currents

→ 4. Shear stress, sediment transport

→ 5. Bathymetry

→…restoration success…



1. Tidal energy

- △ Elevation and velocity (~ rate of work done)

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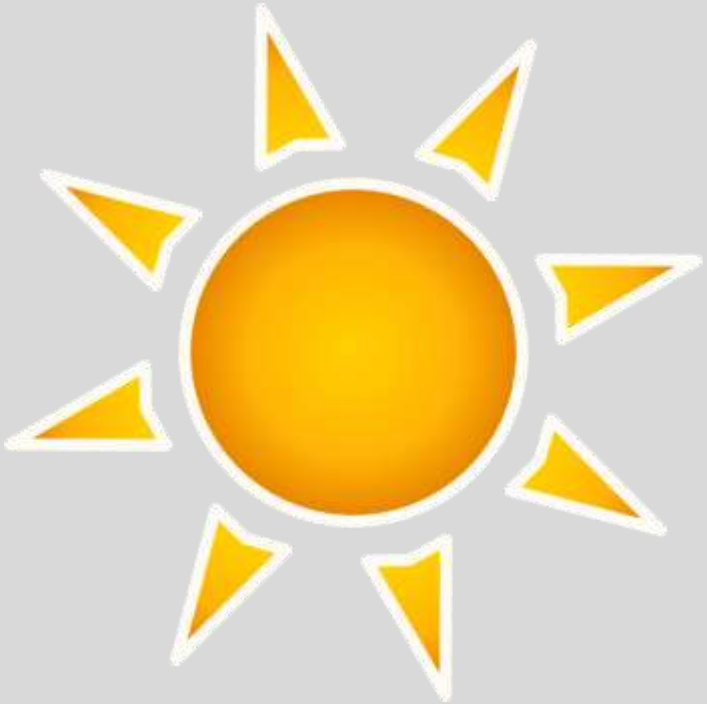

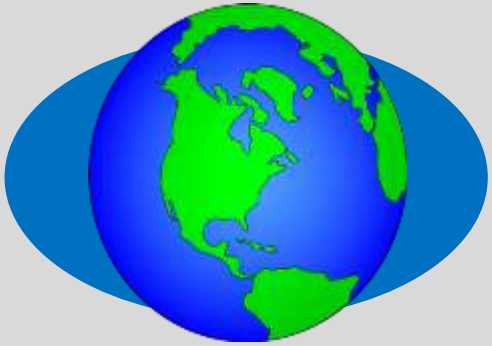

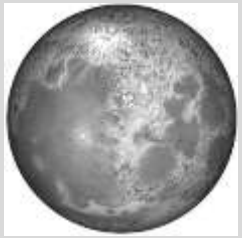

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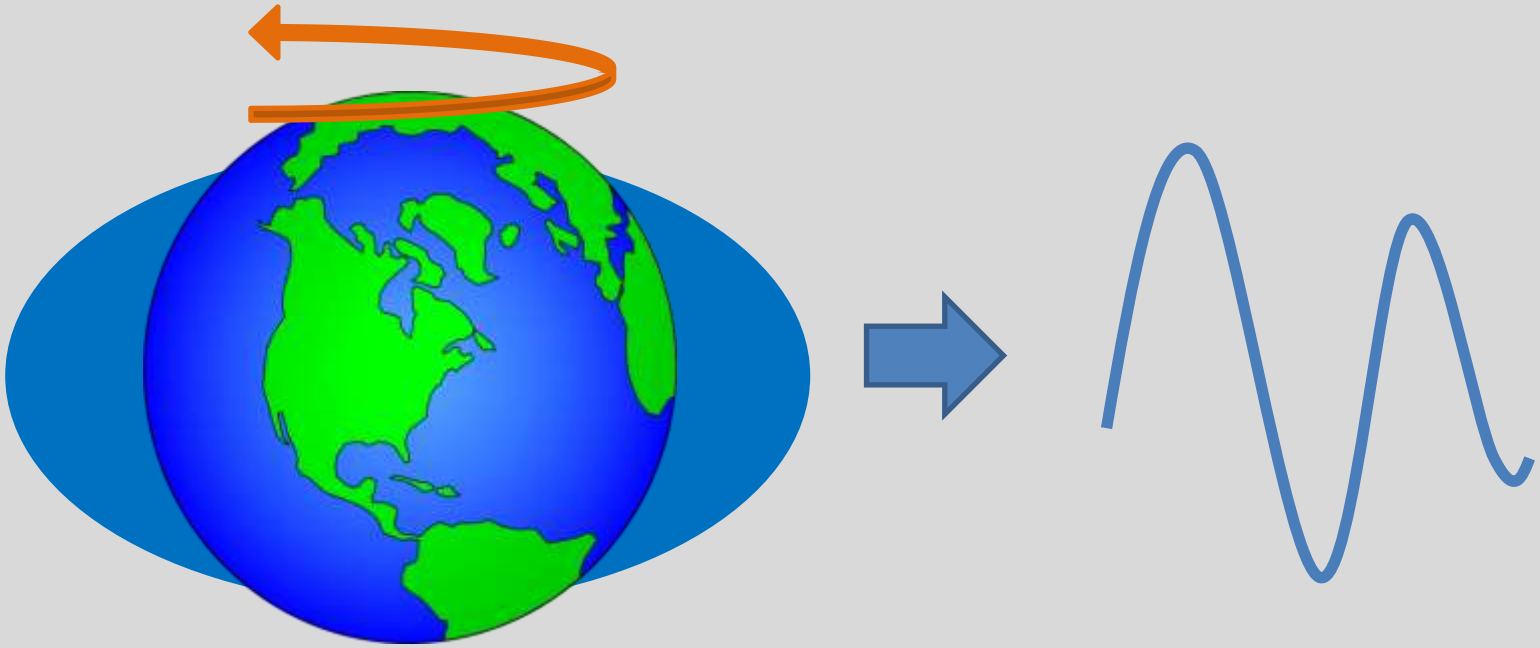
- △ Elevation and velocity (~ rate of work done)
- Sun/moon & centripetal force bulge oceans
- Tide = Earth rotation through the bulge 2x/day



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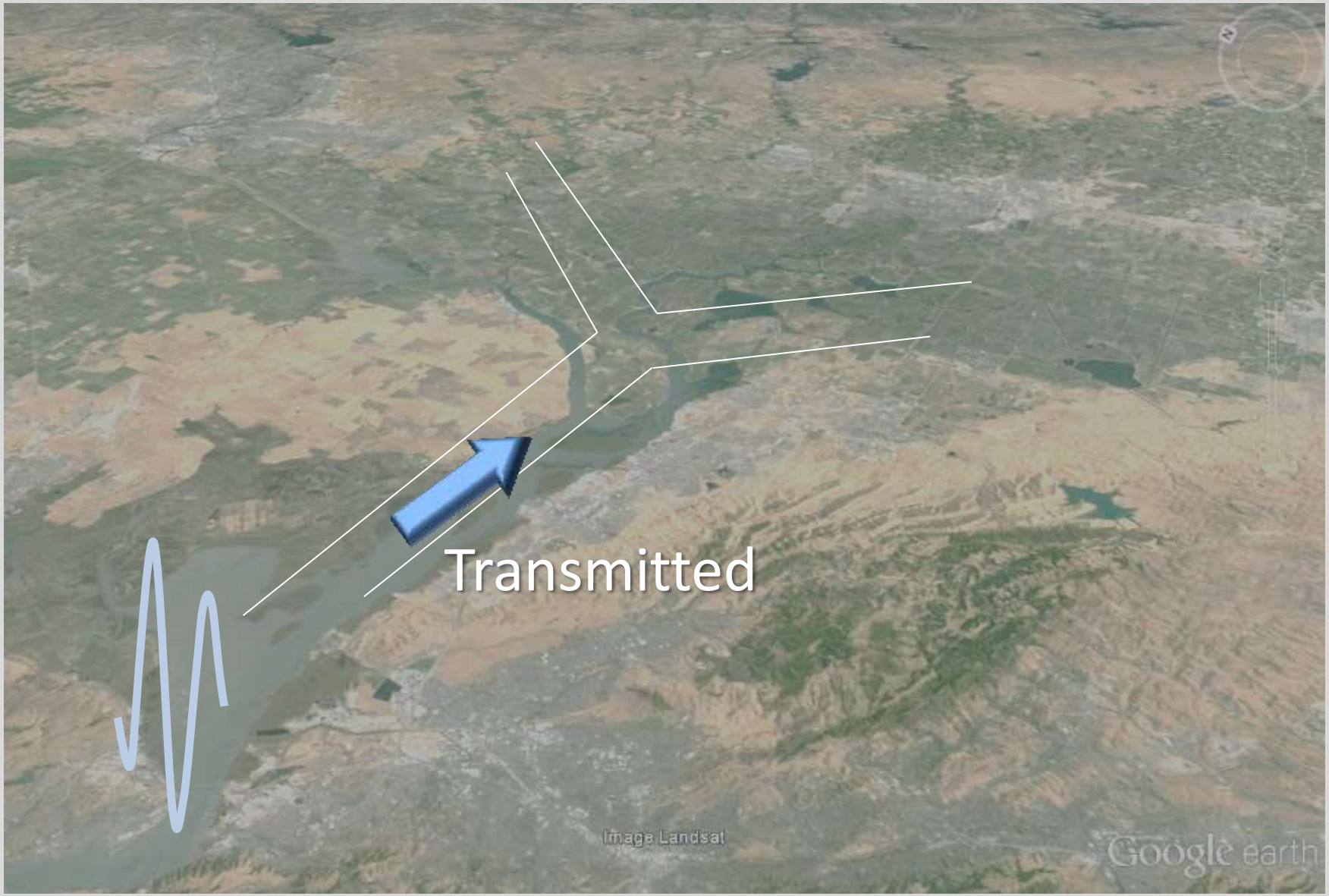

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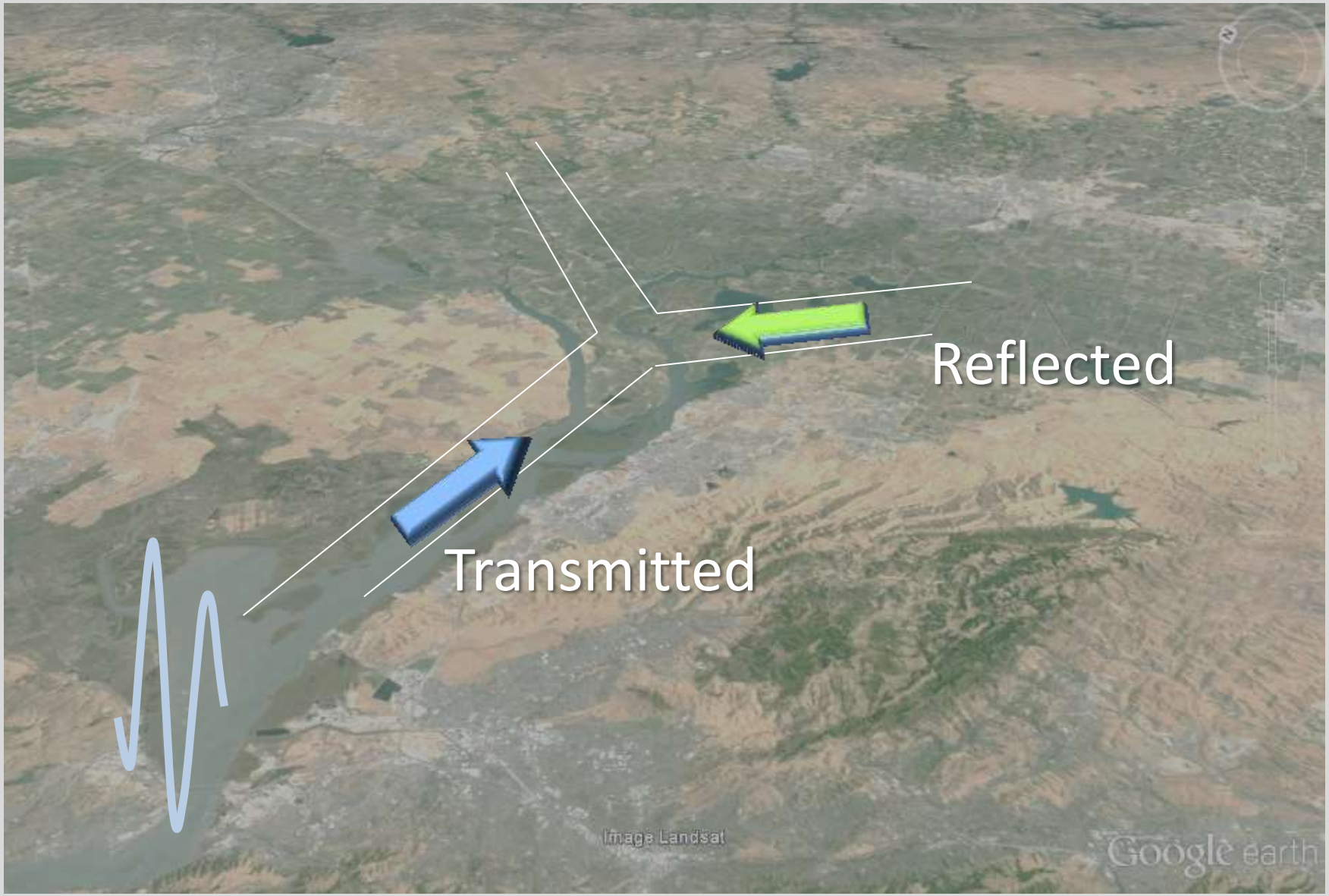

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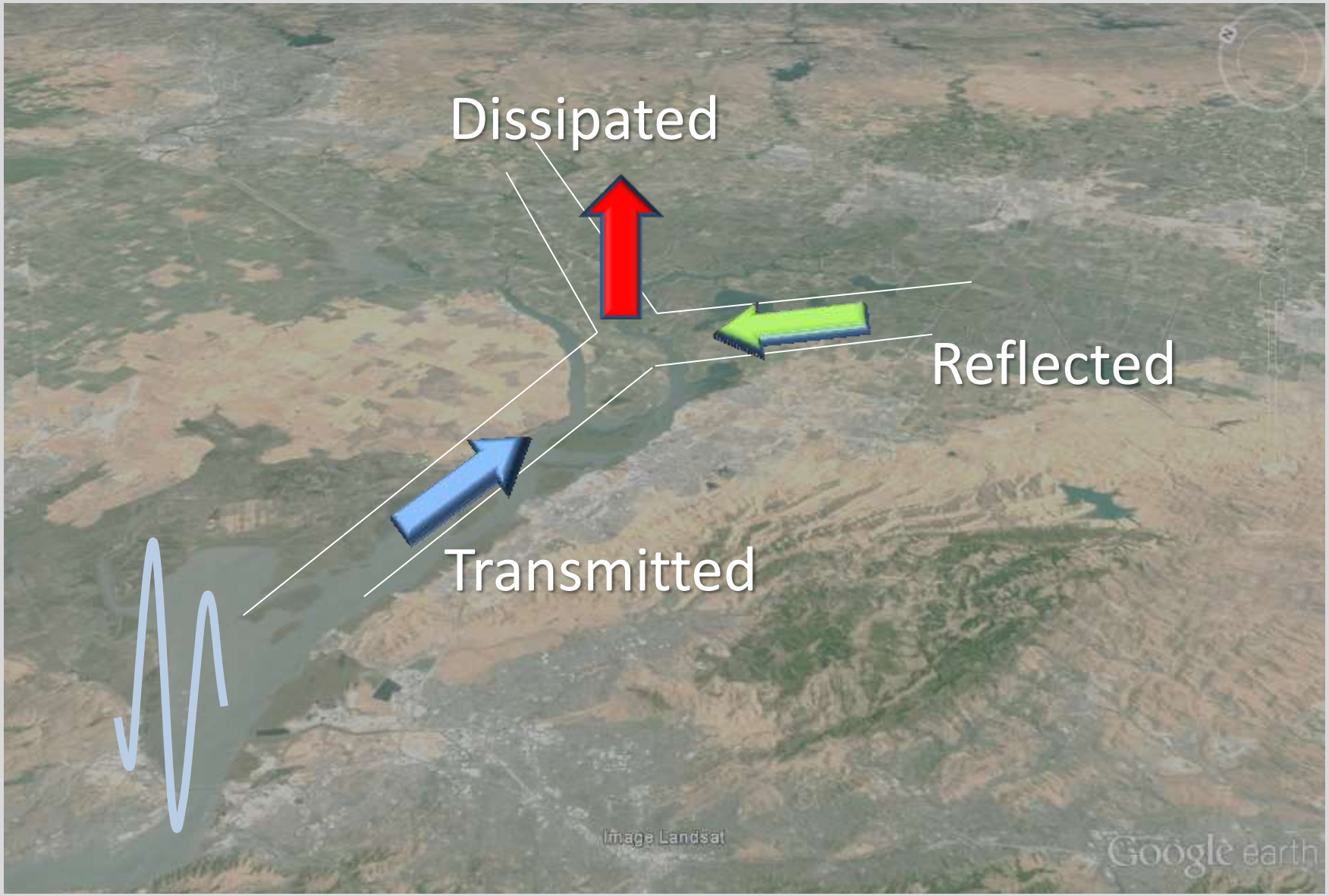
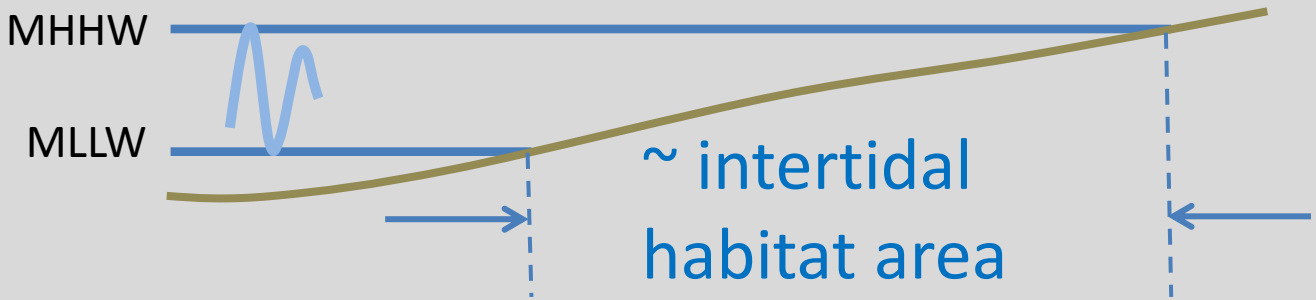


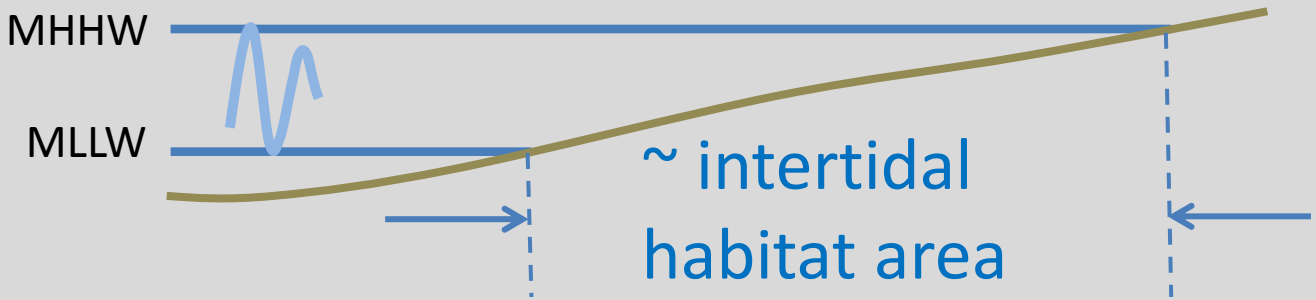
1. Tidal energy

- Tidal energy dissipation determines tidal range



1. Tidal energy

- Tidal energy dissipation determines tidal range
- Tidal range ~ habitat,



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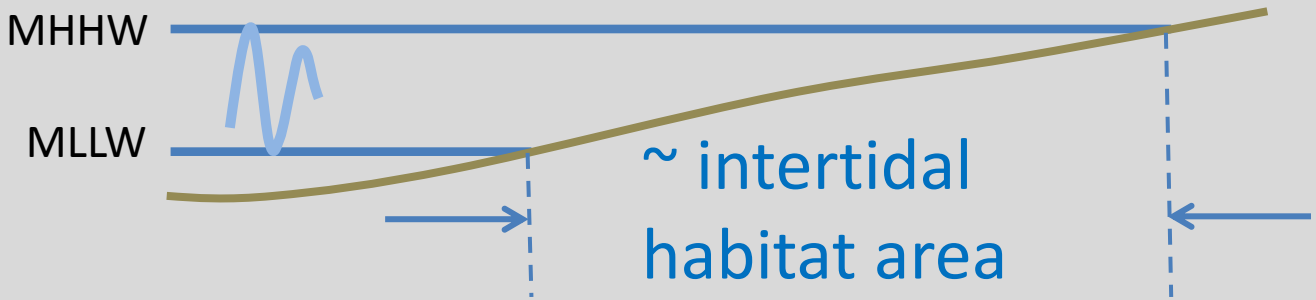

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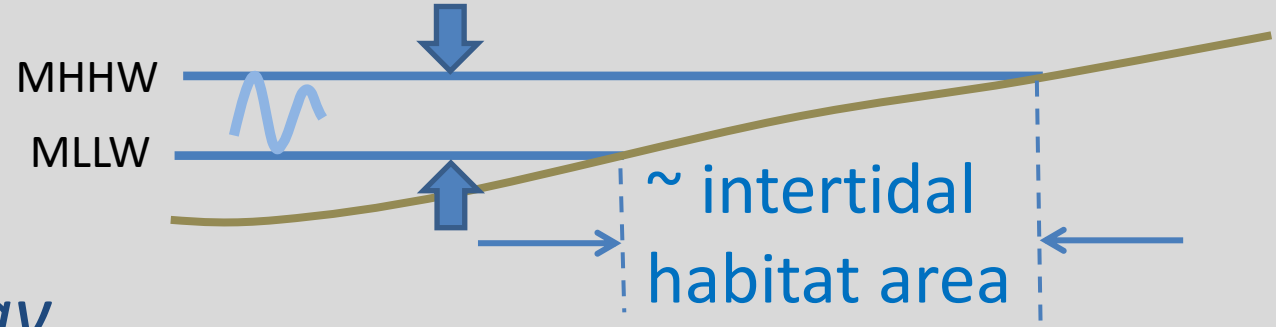

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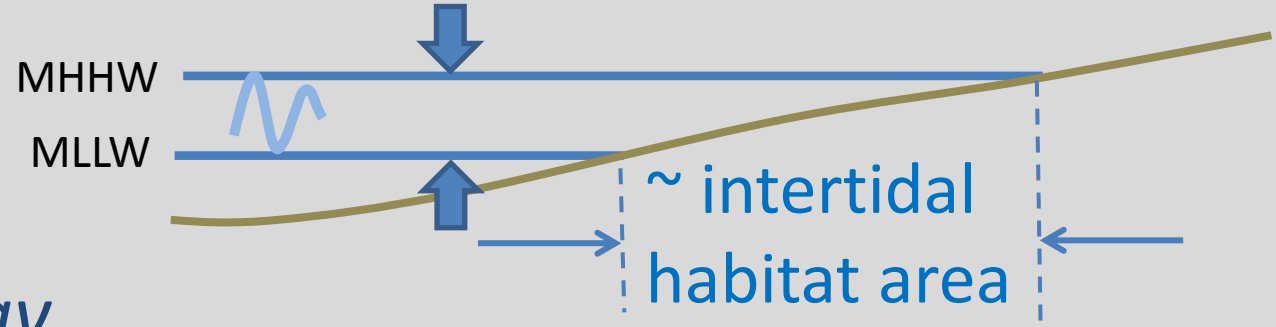
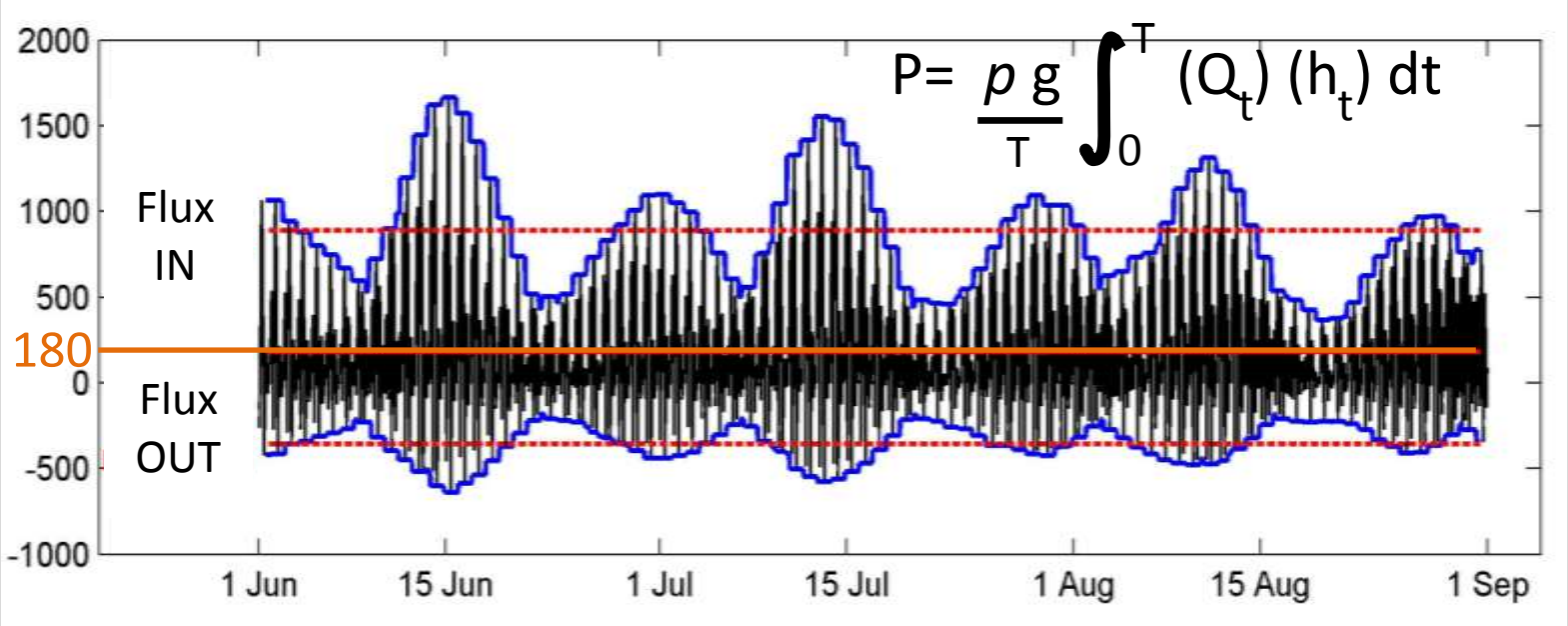


→ *Restoration limits opportunities for restoration*

1. Tidal energy

Golden Gate Energy Flux (MW)



Average flux = 180 MW = dissipation

Thanks to John DeGeorge

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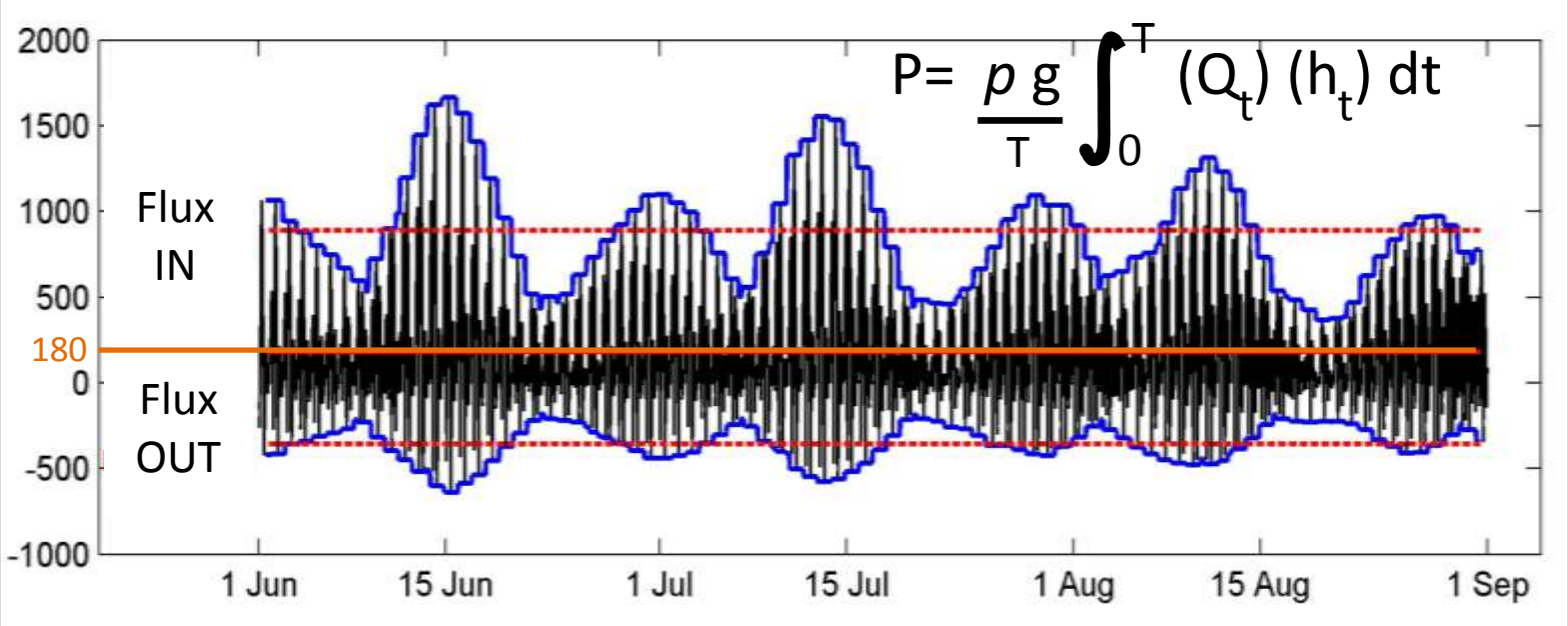
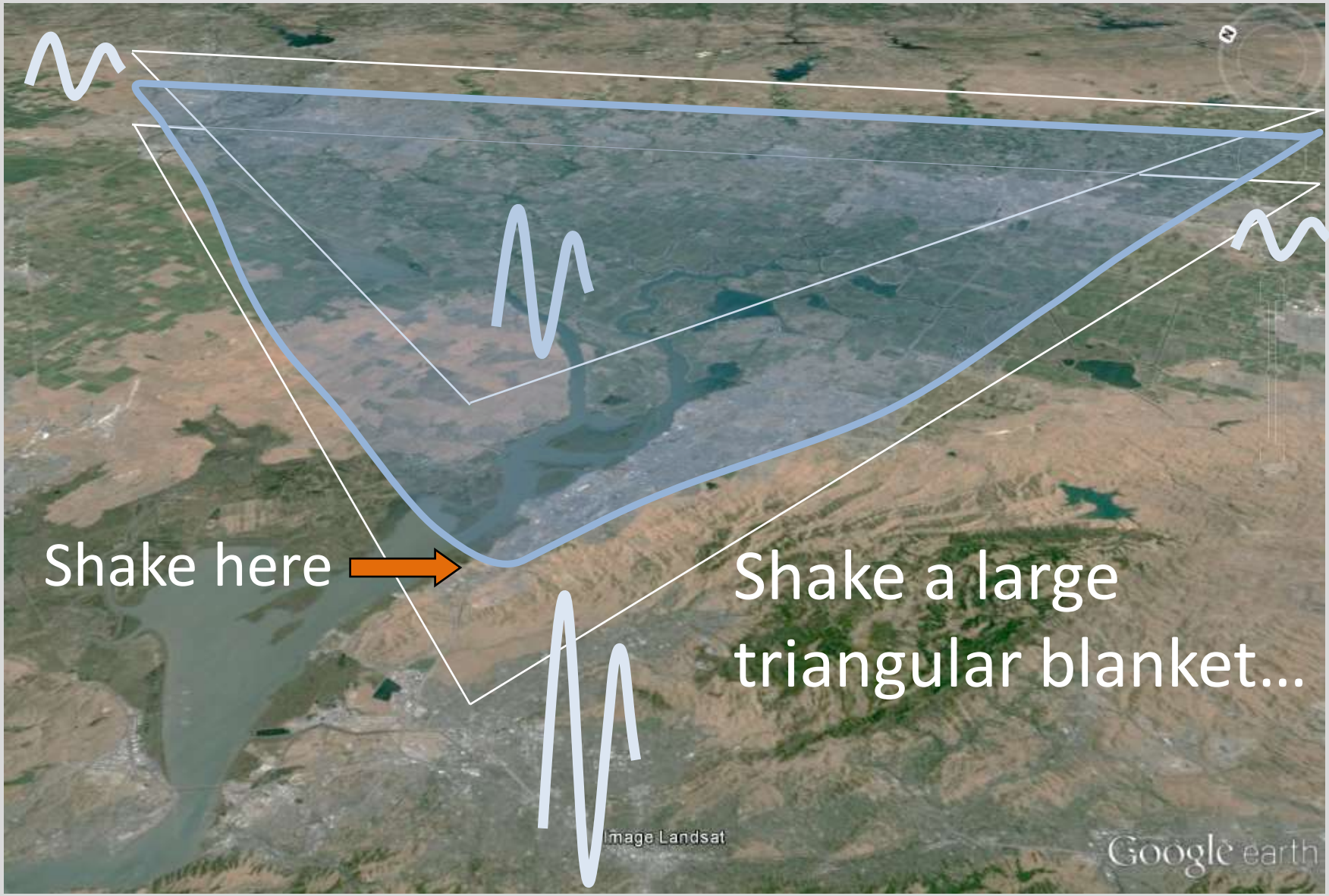


Average flux = 180 MW = dissipation

A finite amount—like a "budget"

Thanks to John DeGeorge

2. Tidal range



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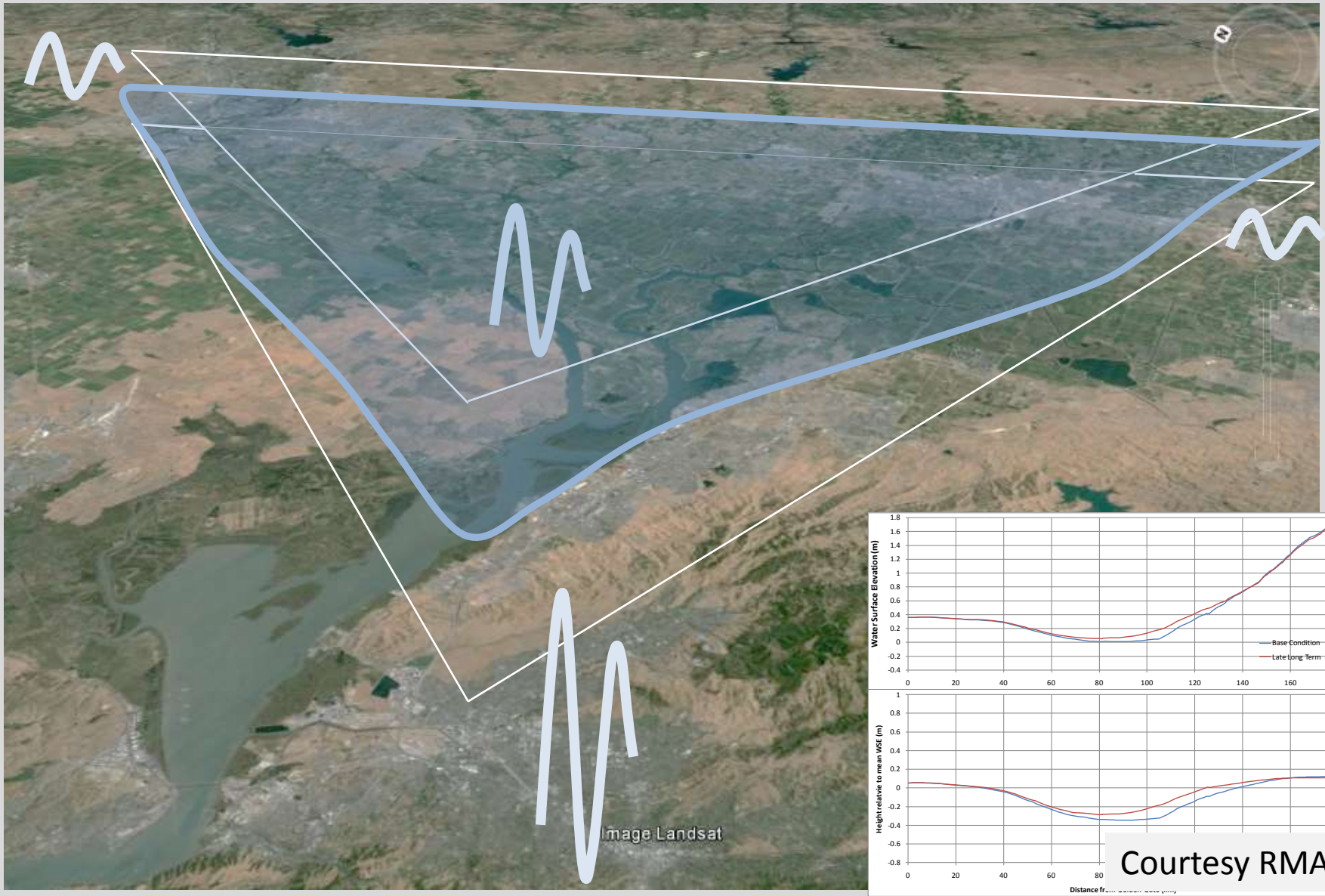

Courtesy RMA

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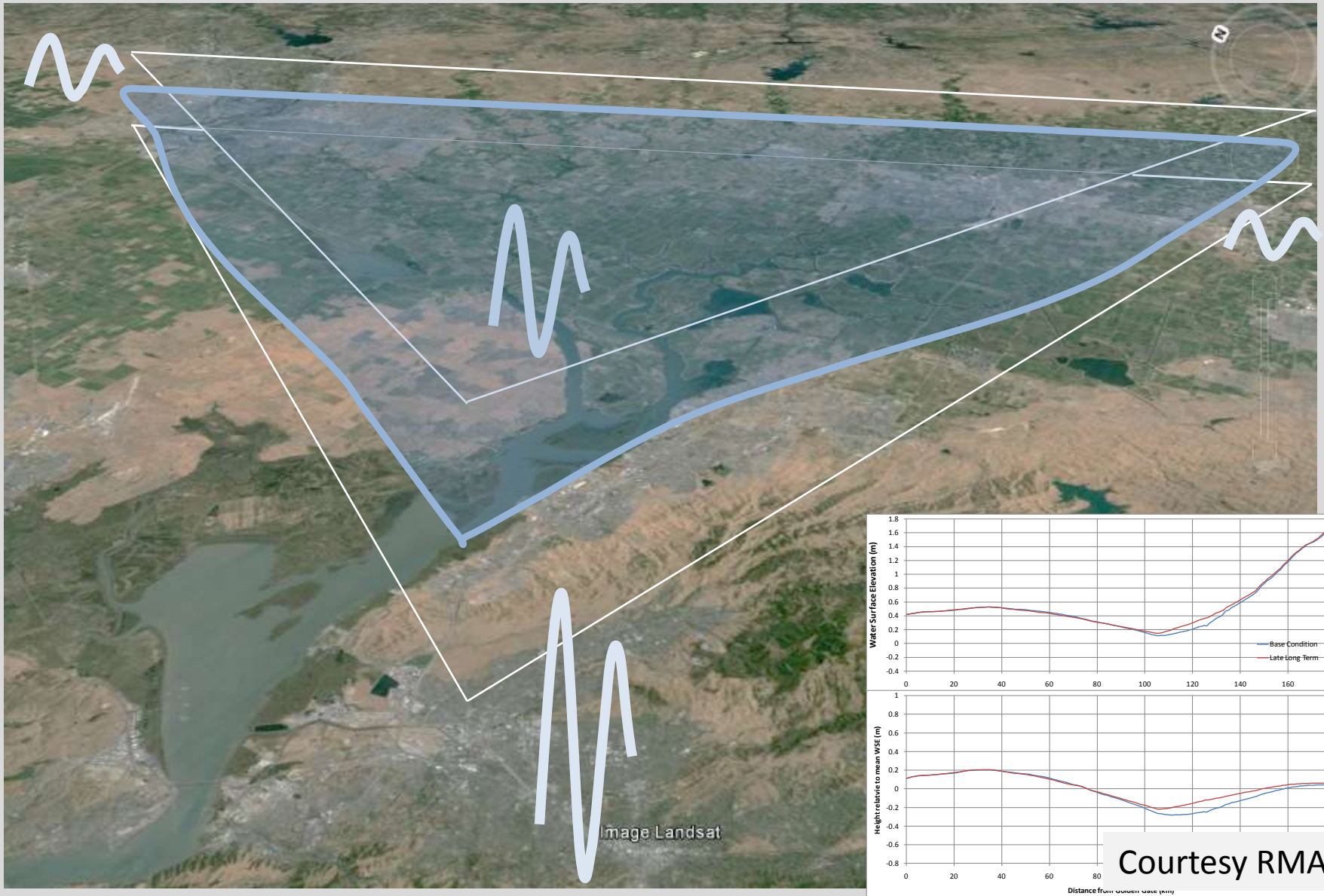

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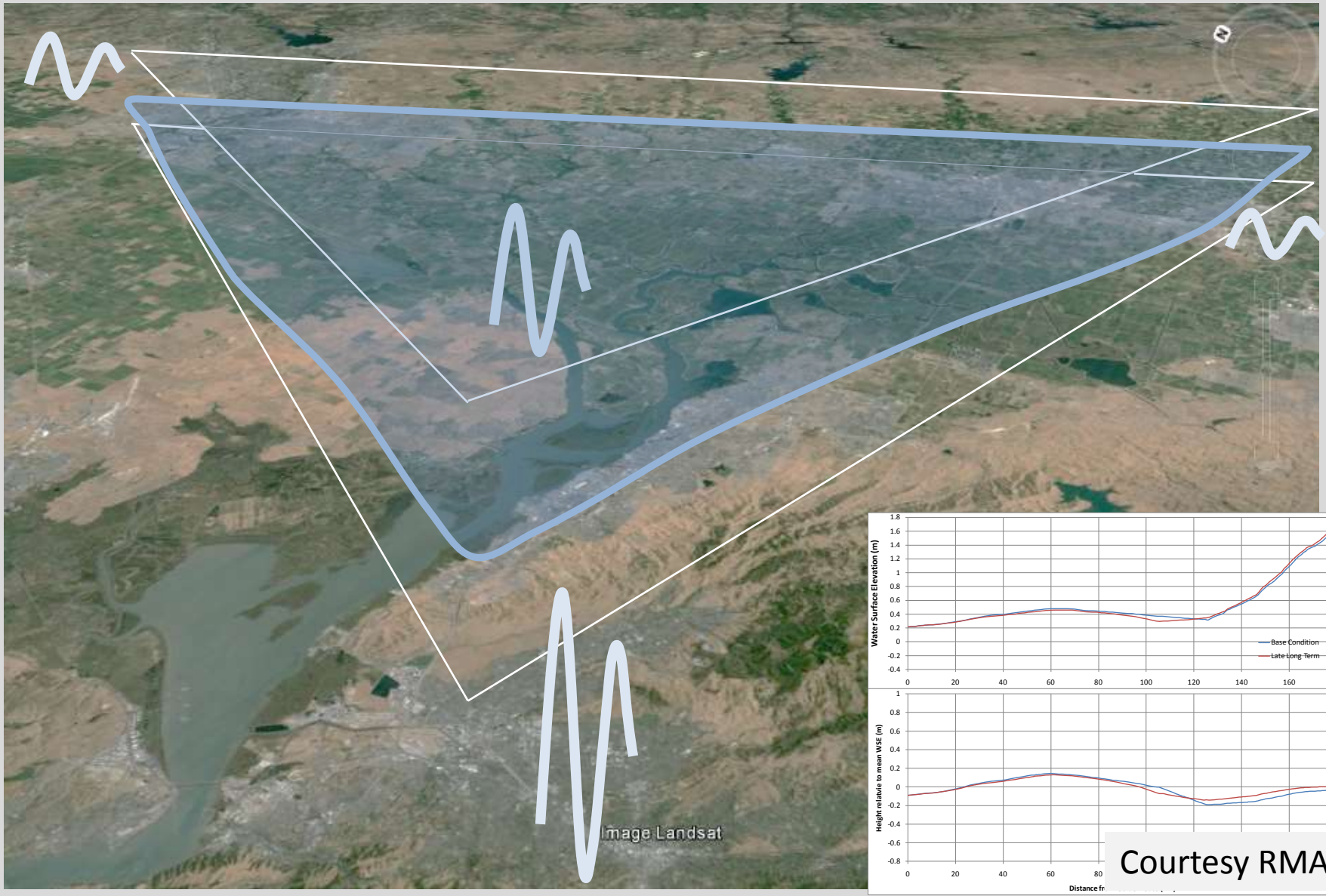

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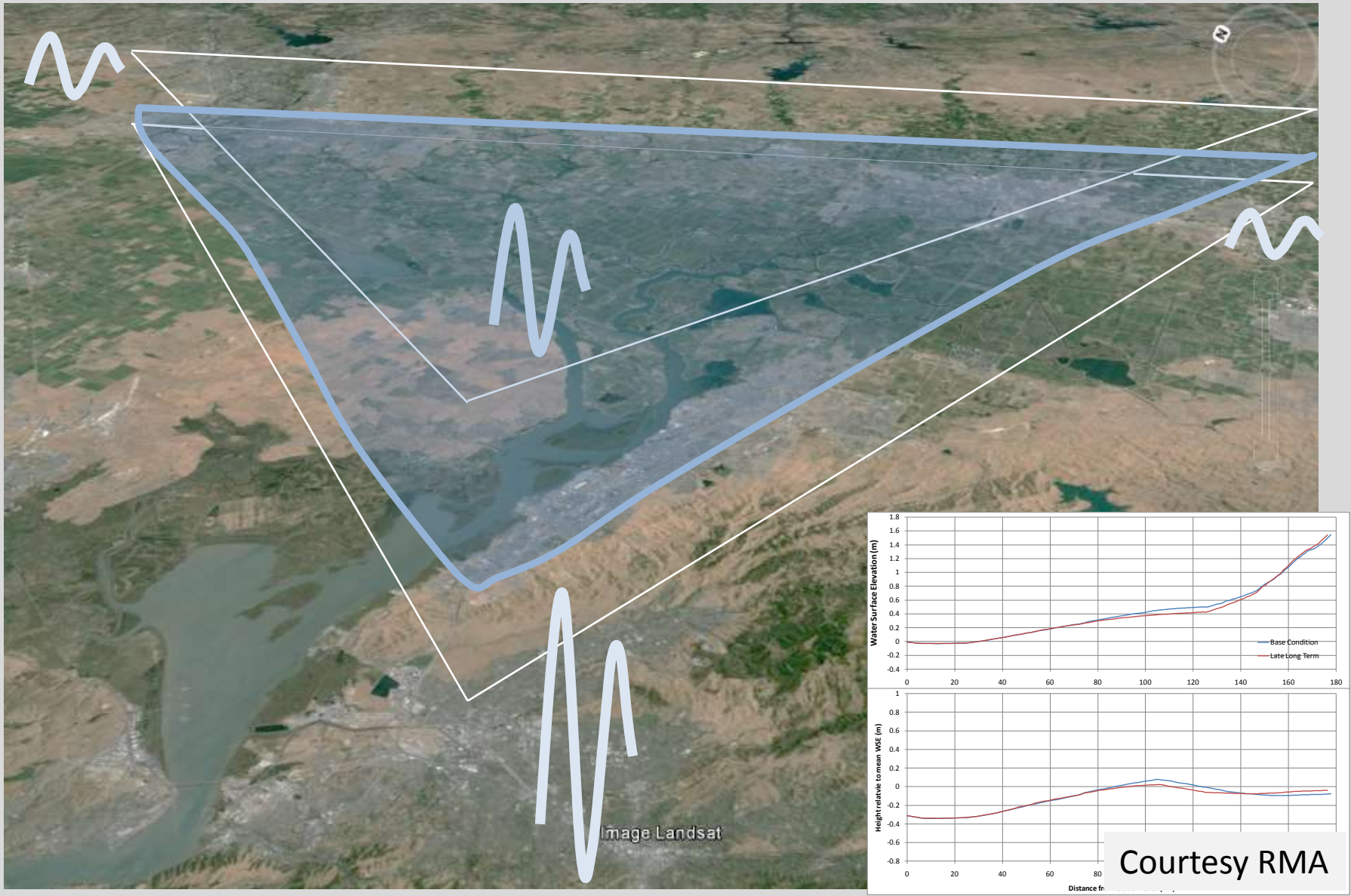

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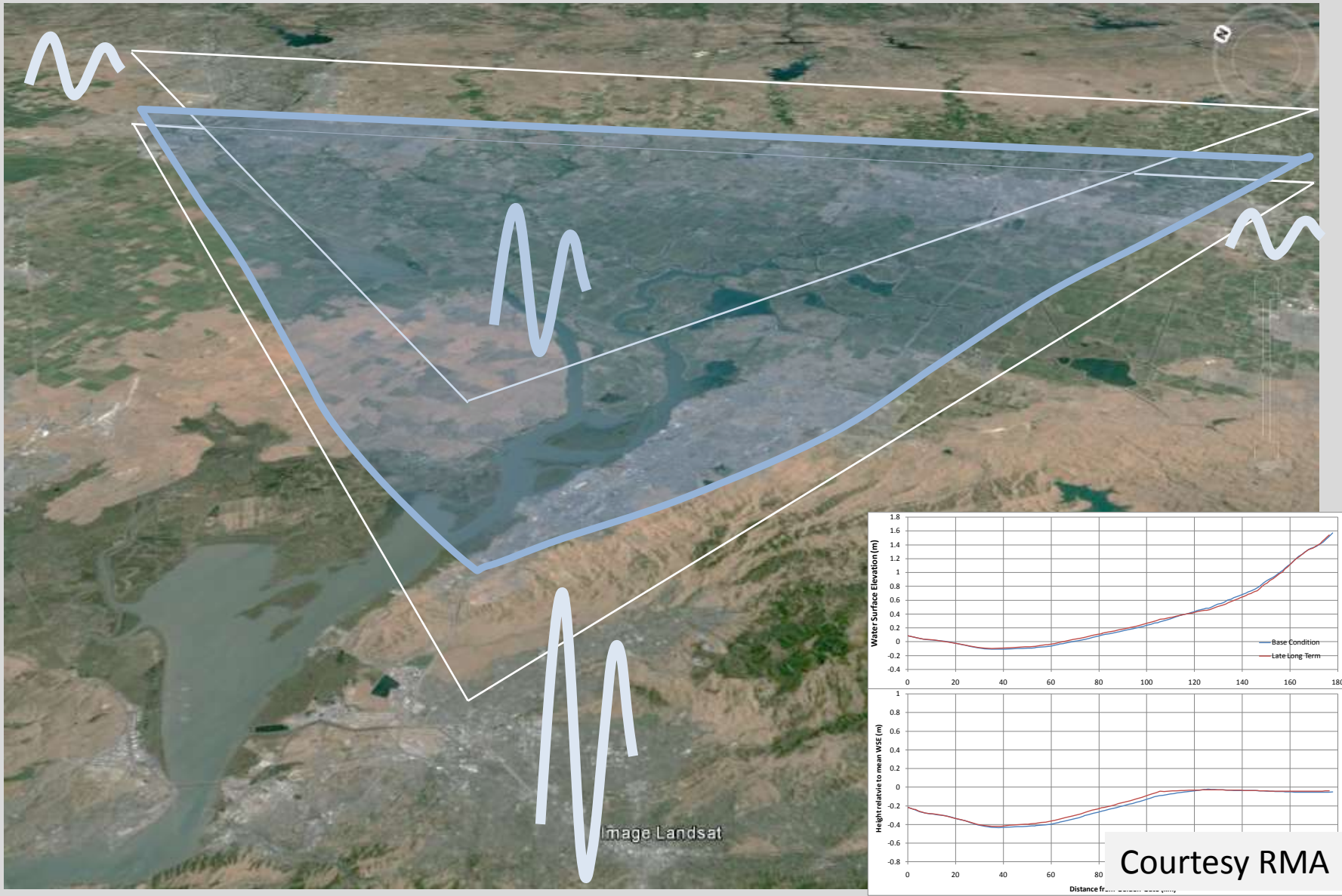

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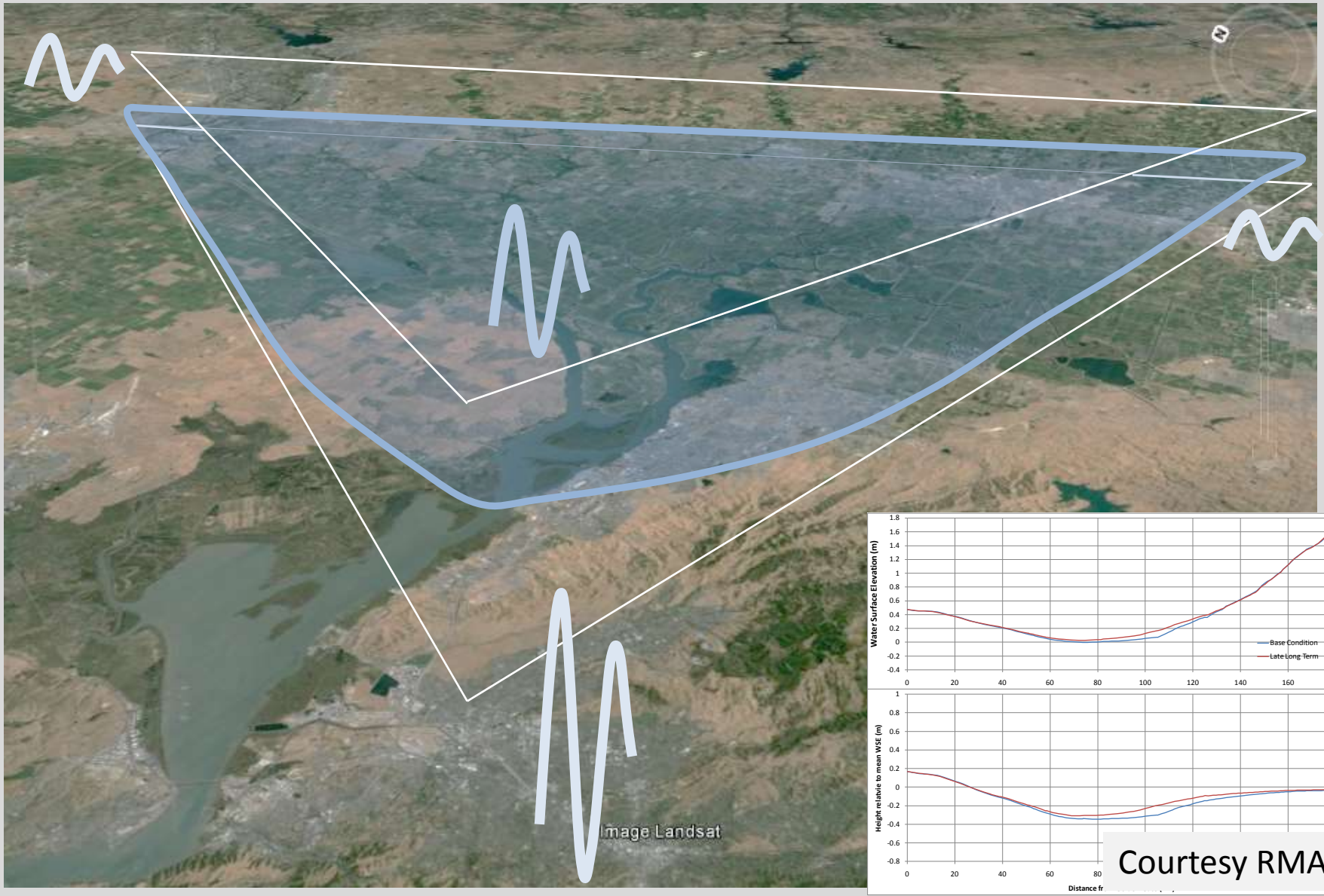

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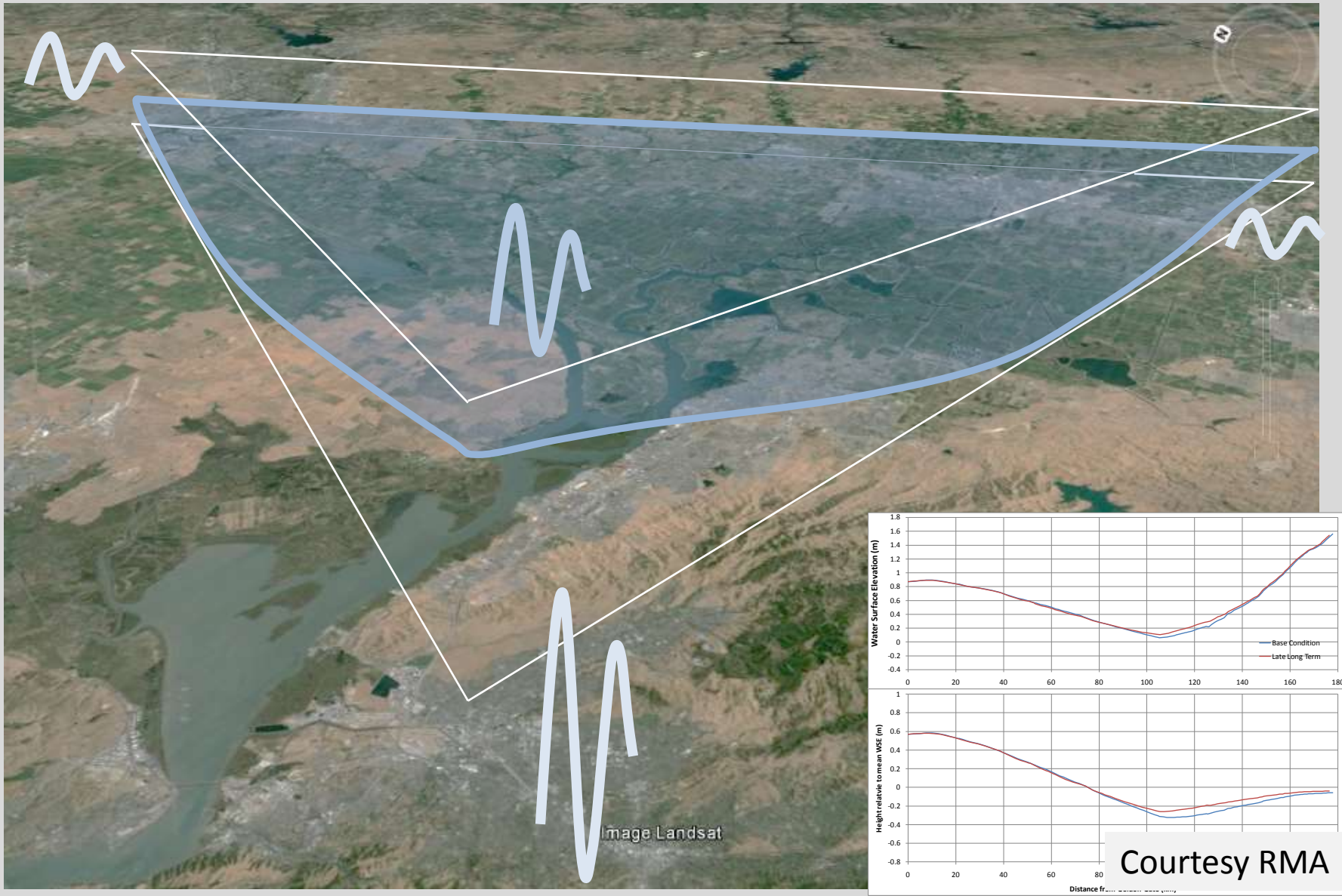

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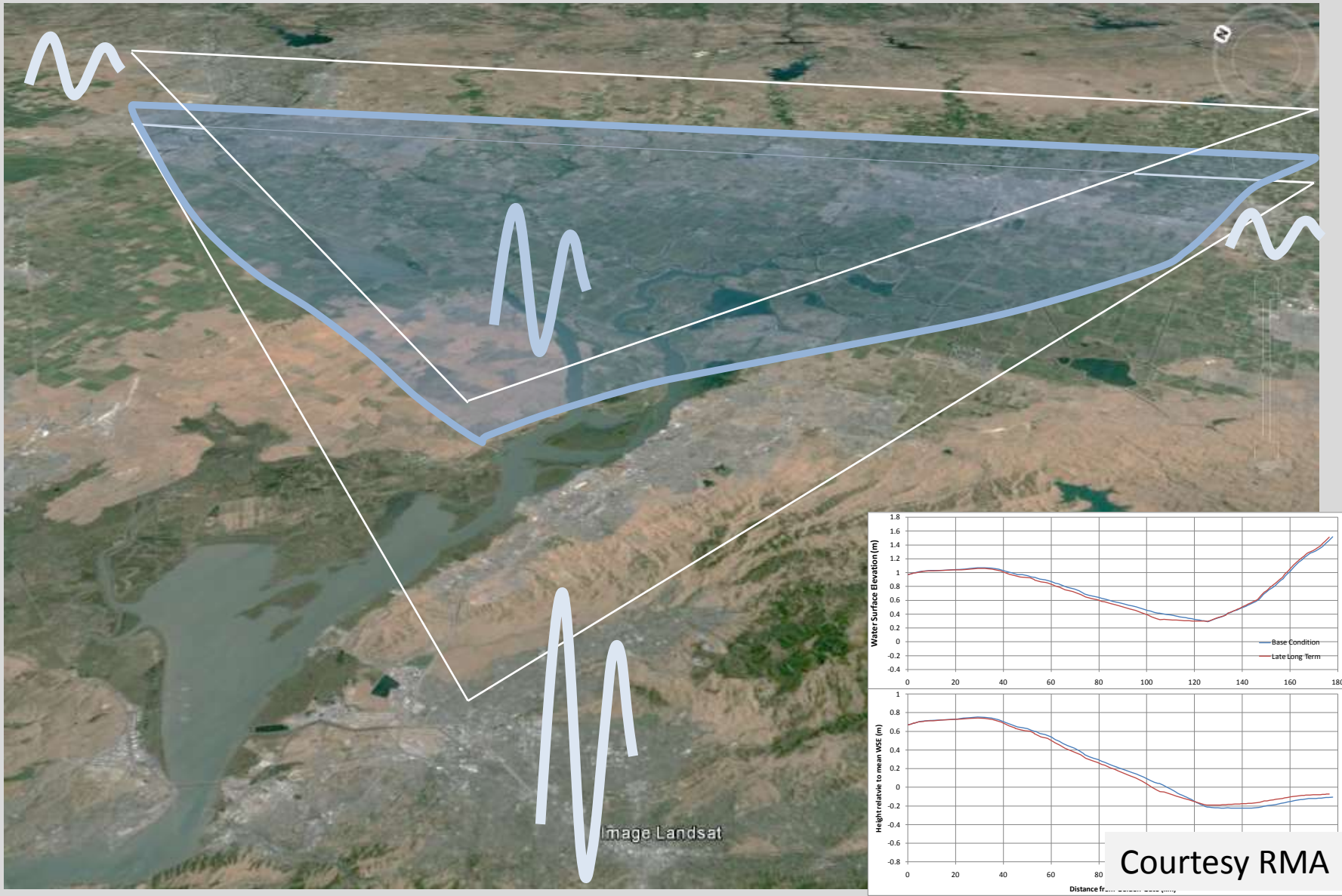

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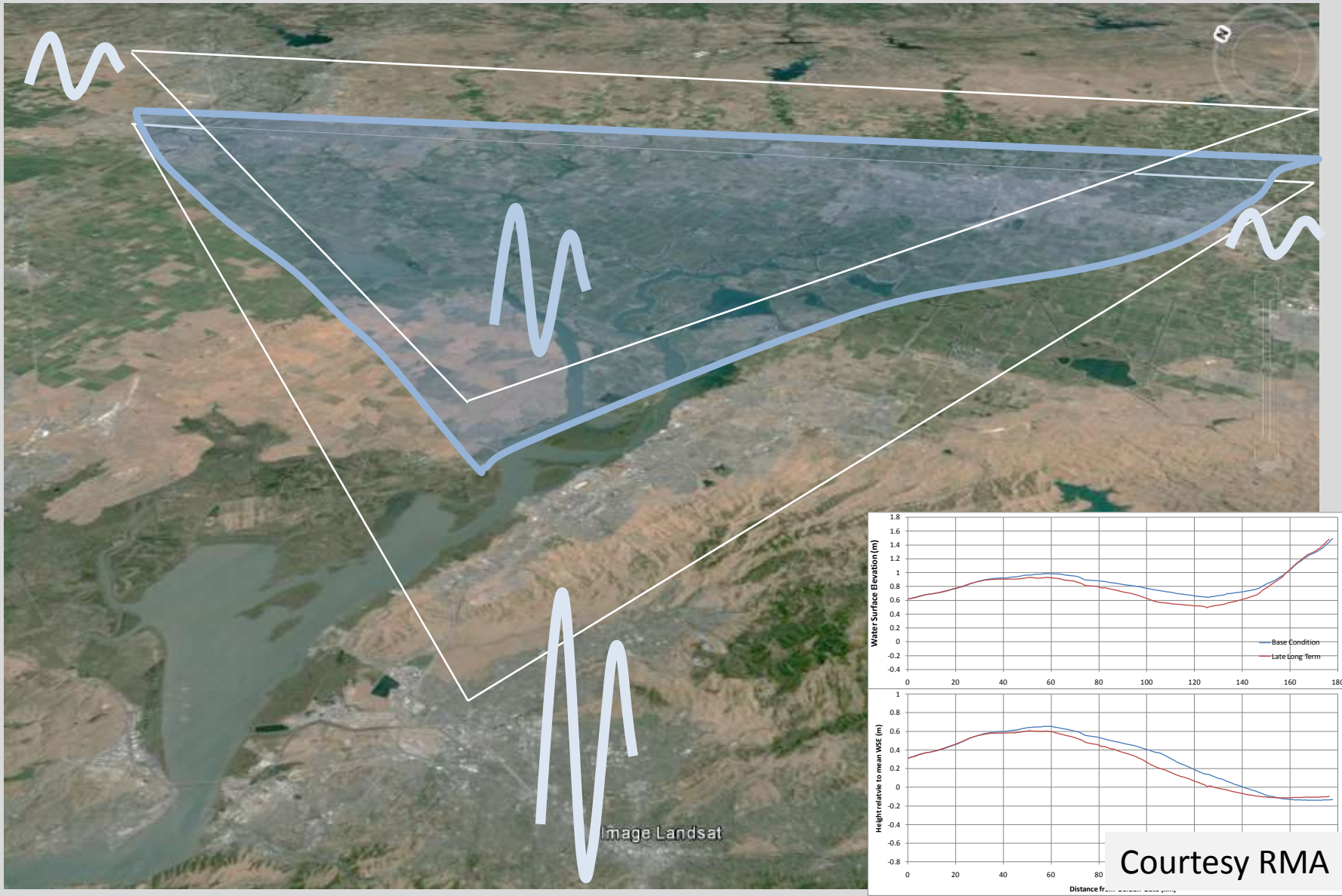

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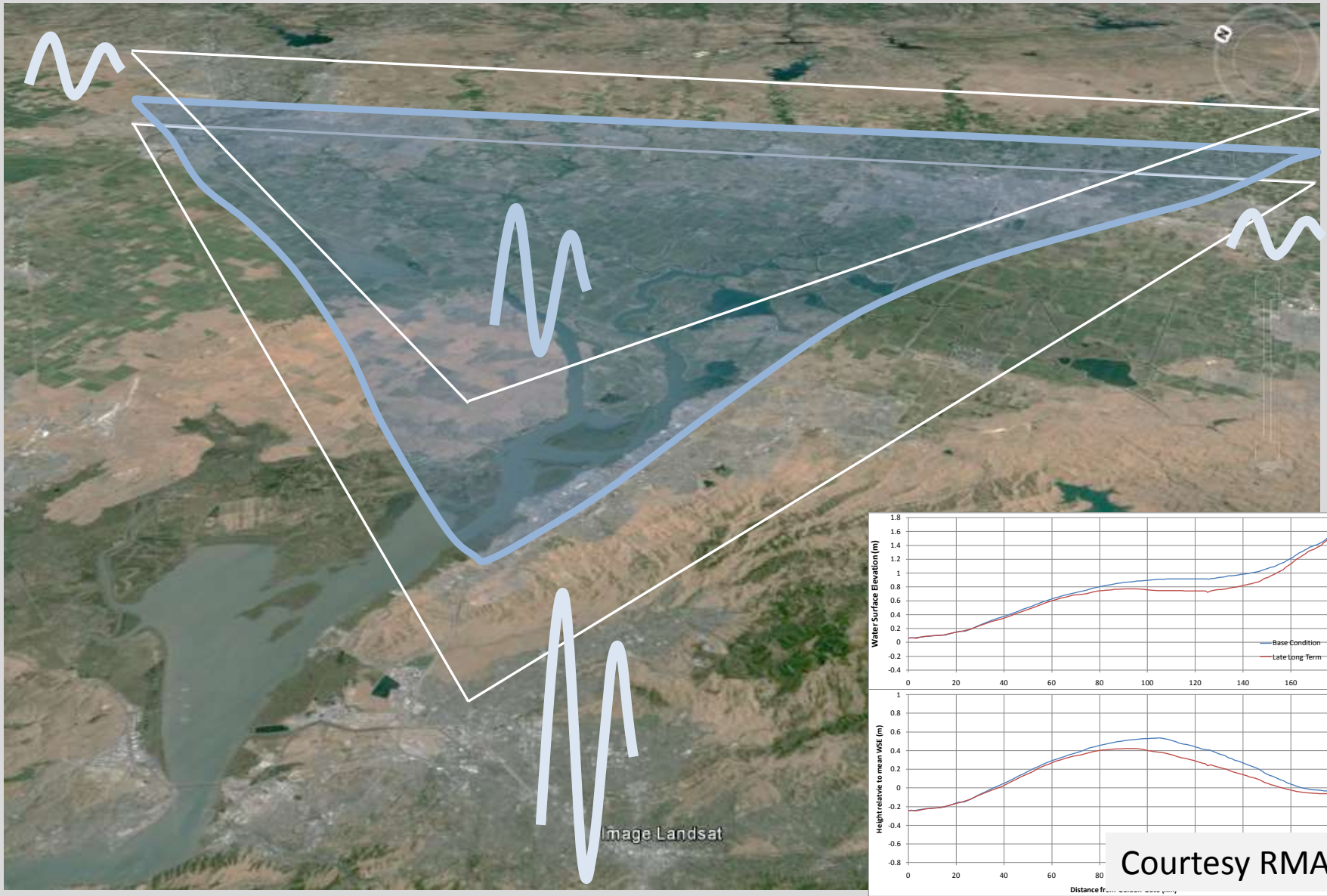

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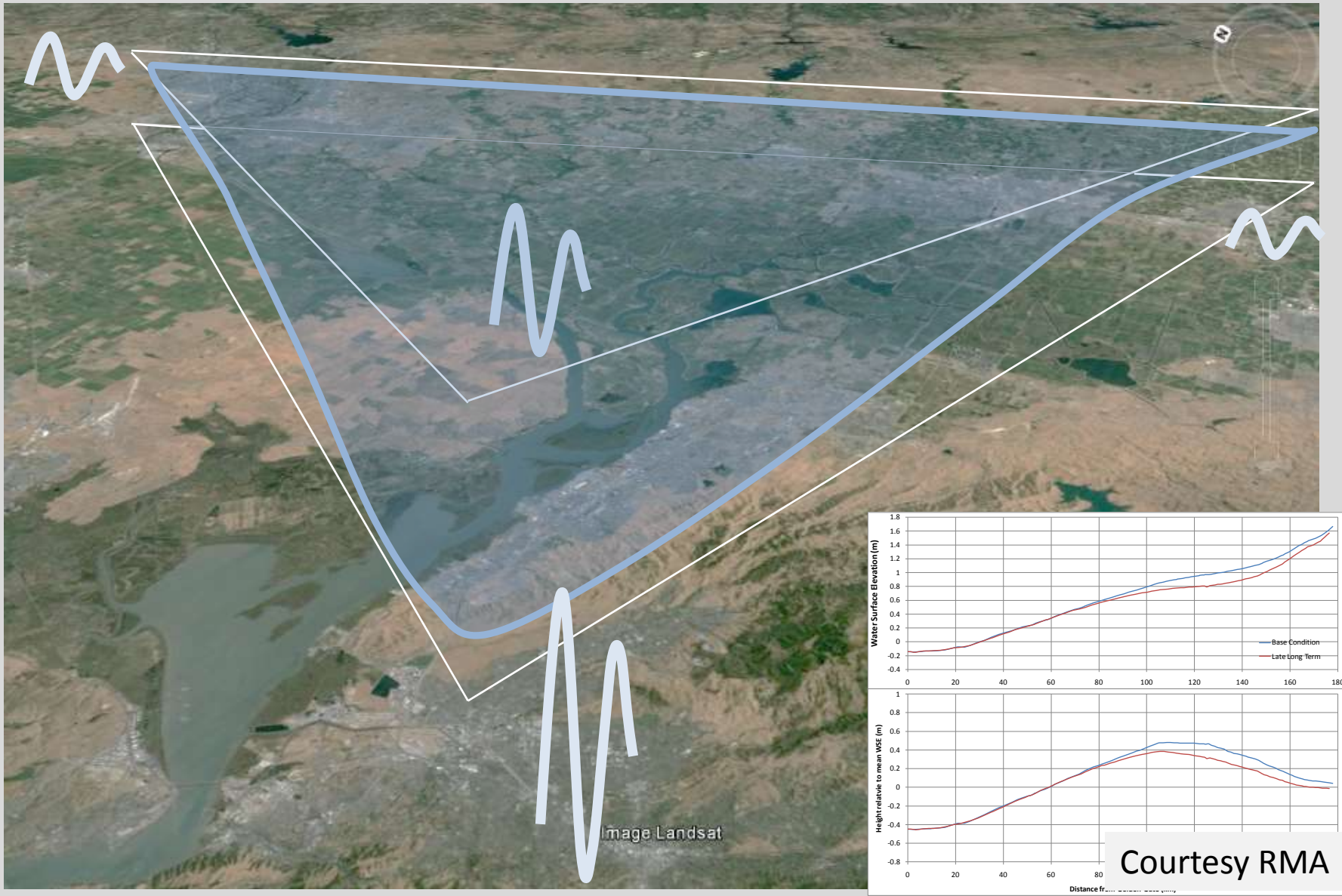

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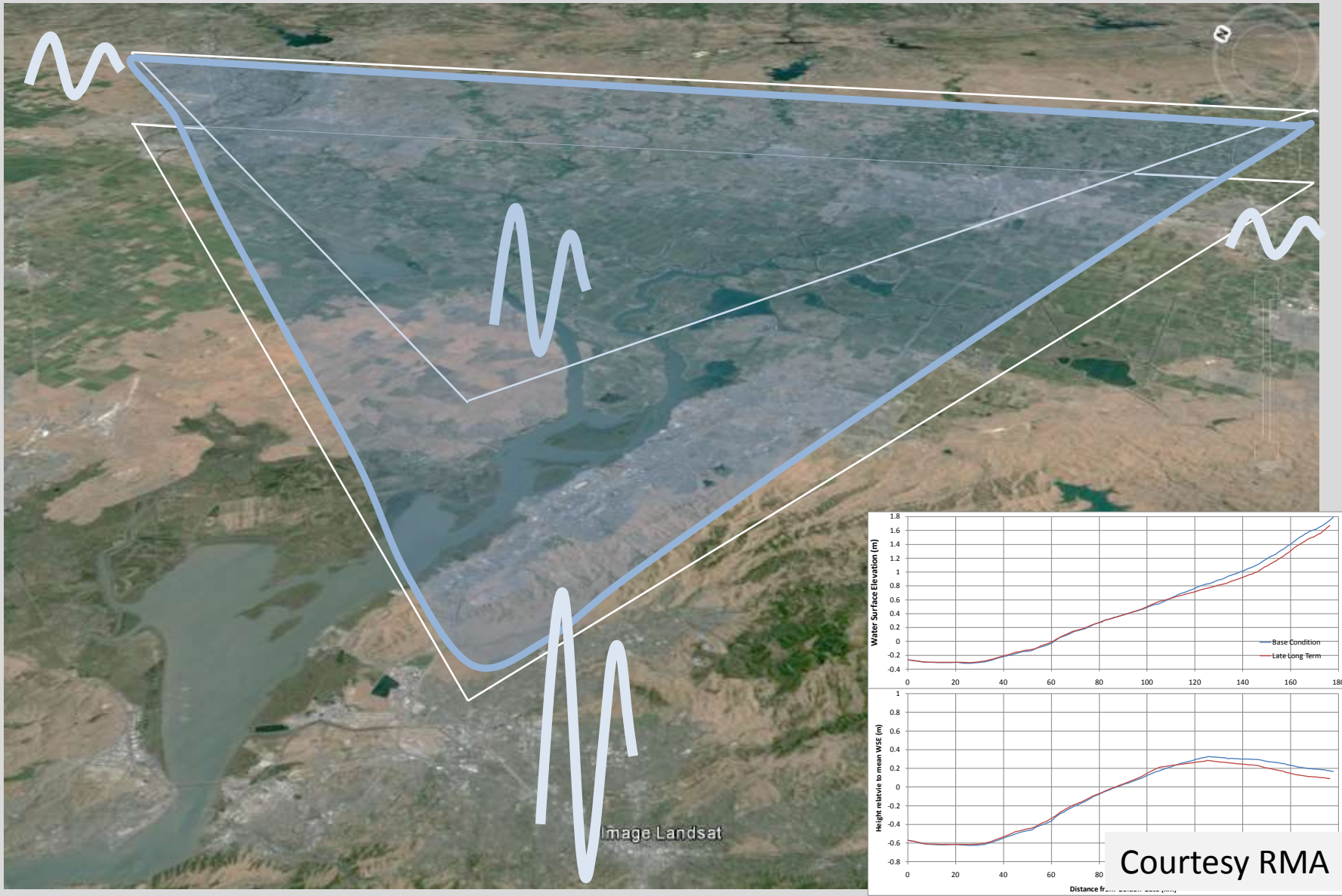

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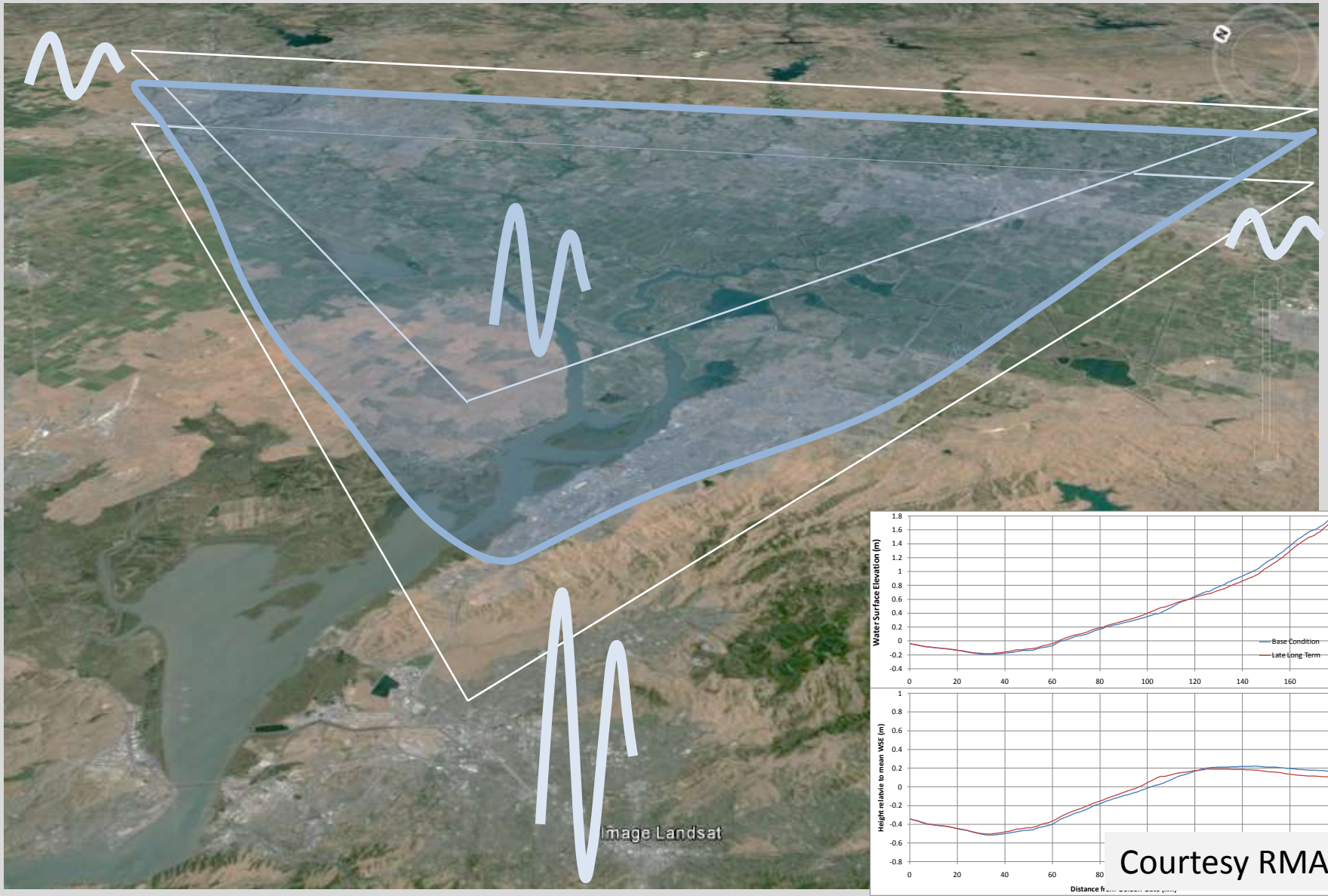

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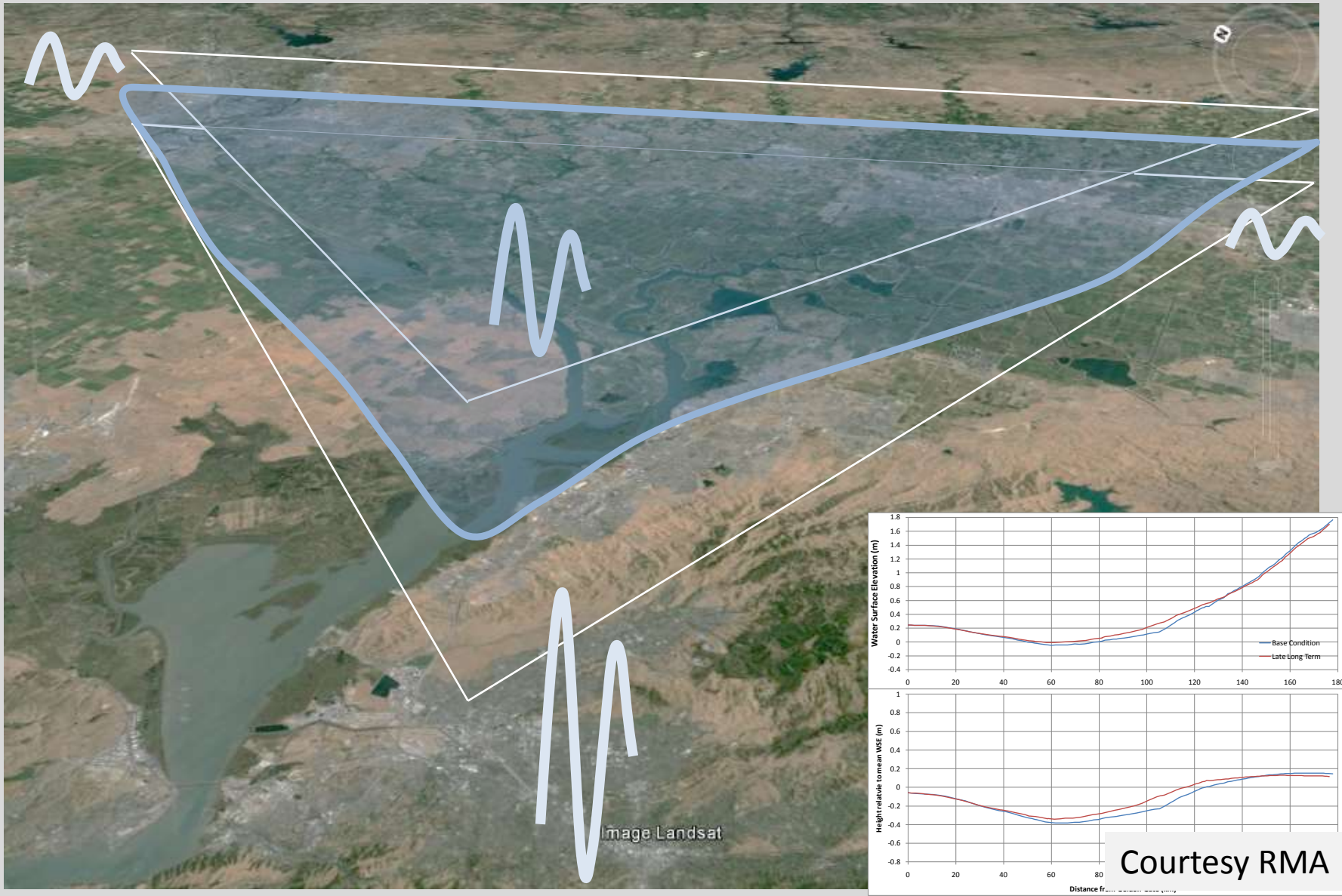

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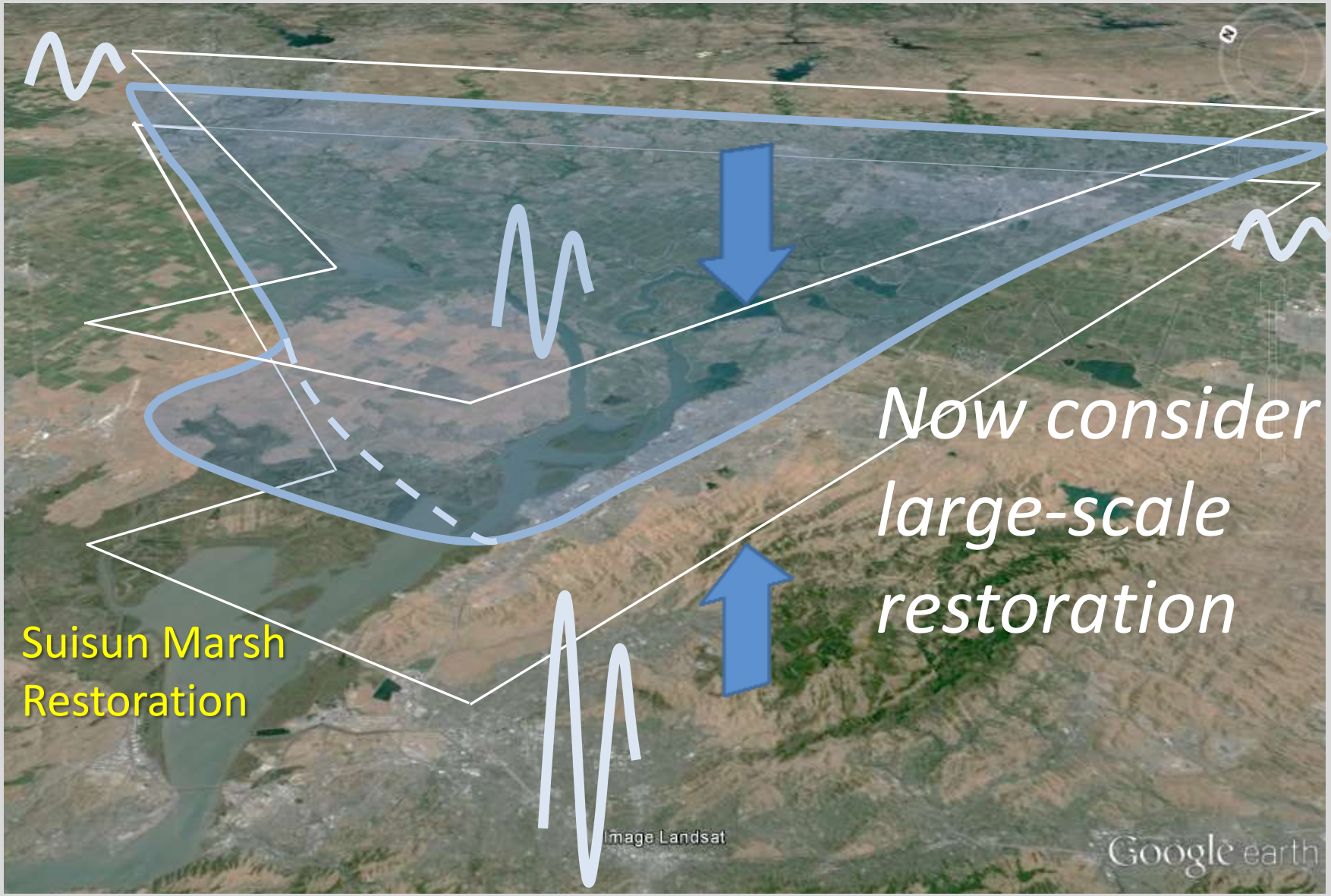

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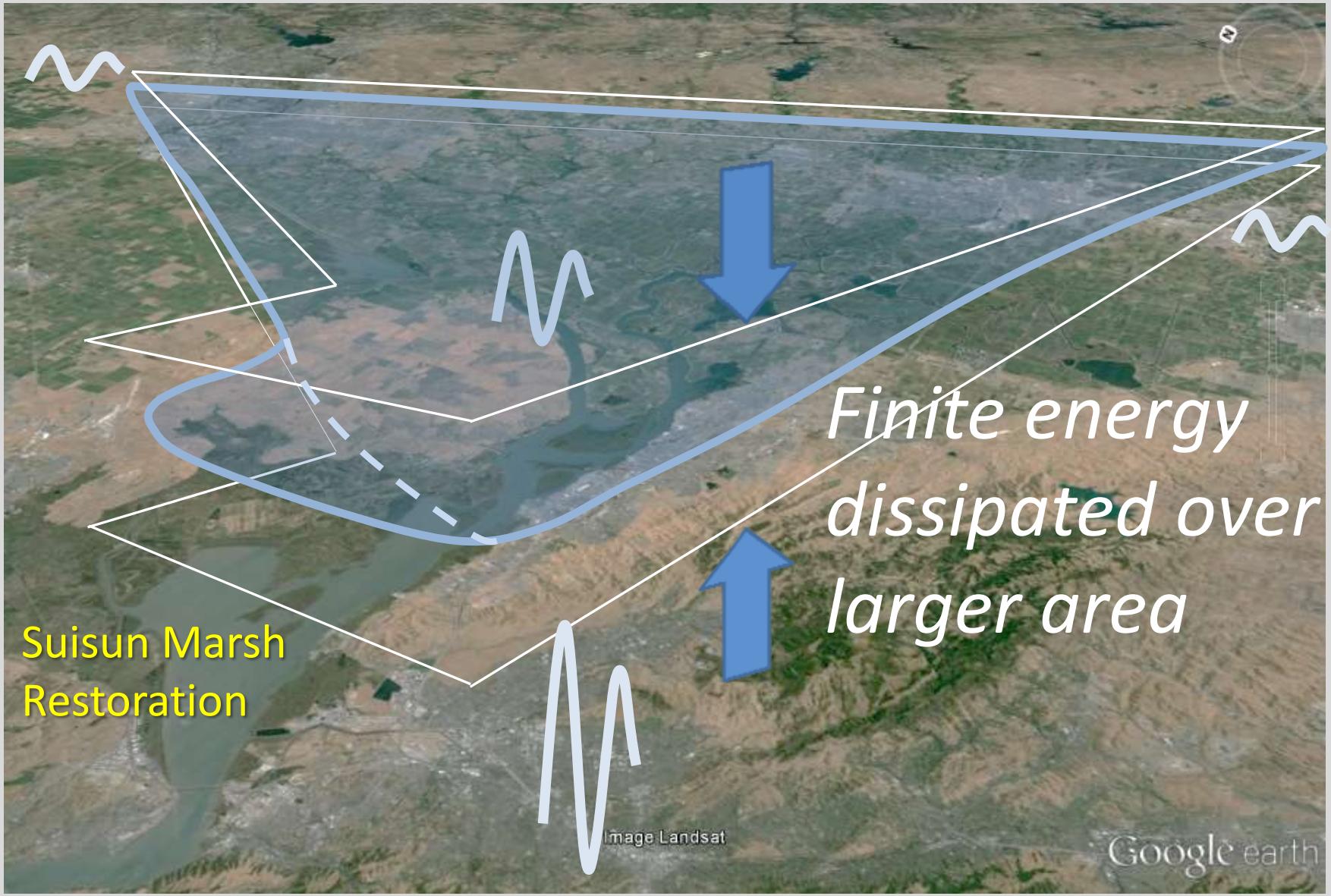

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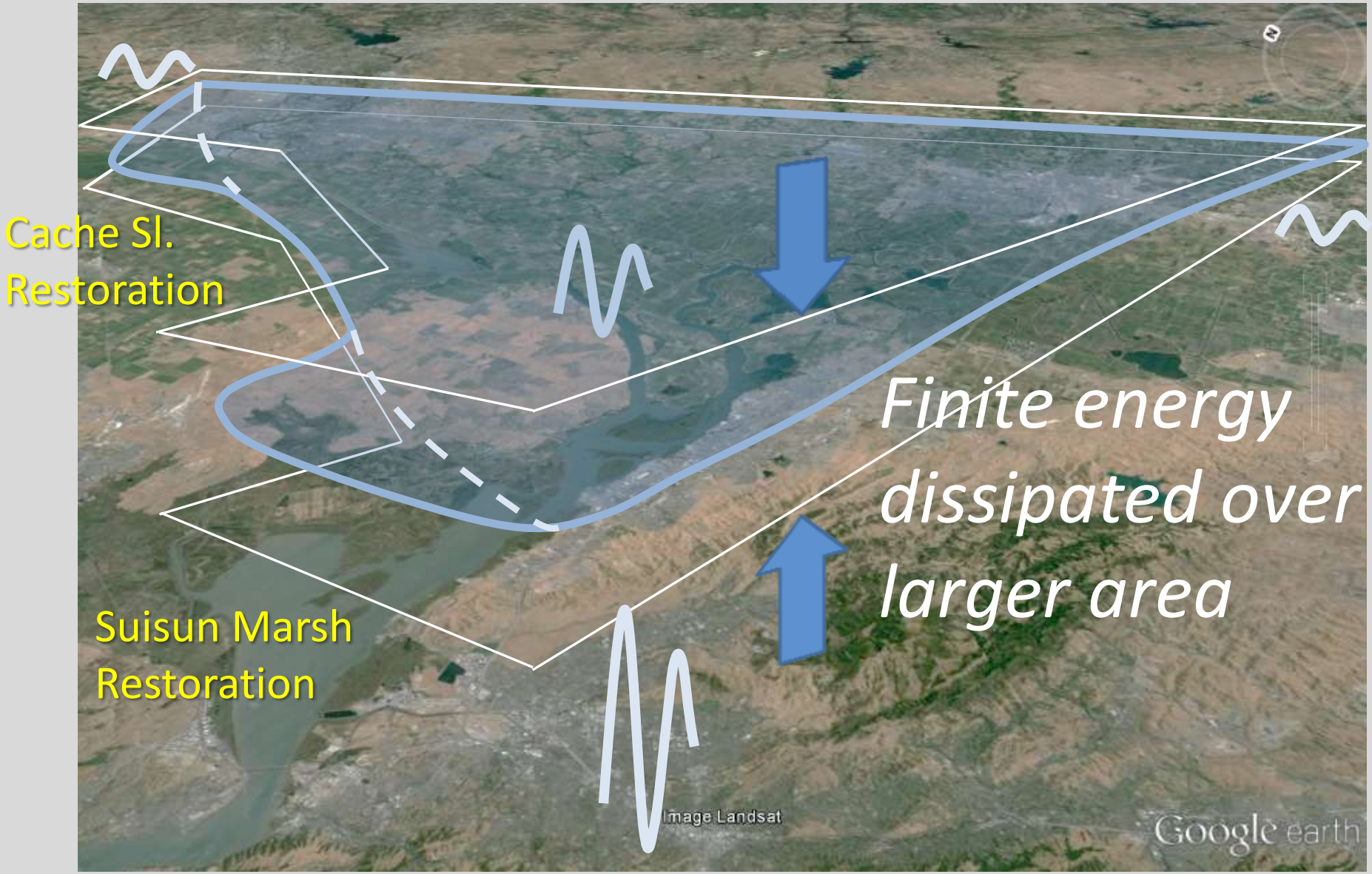

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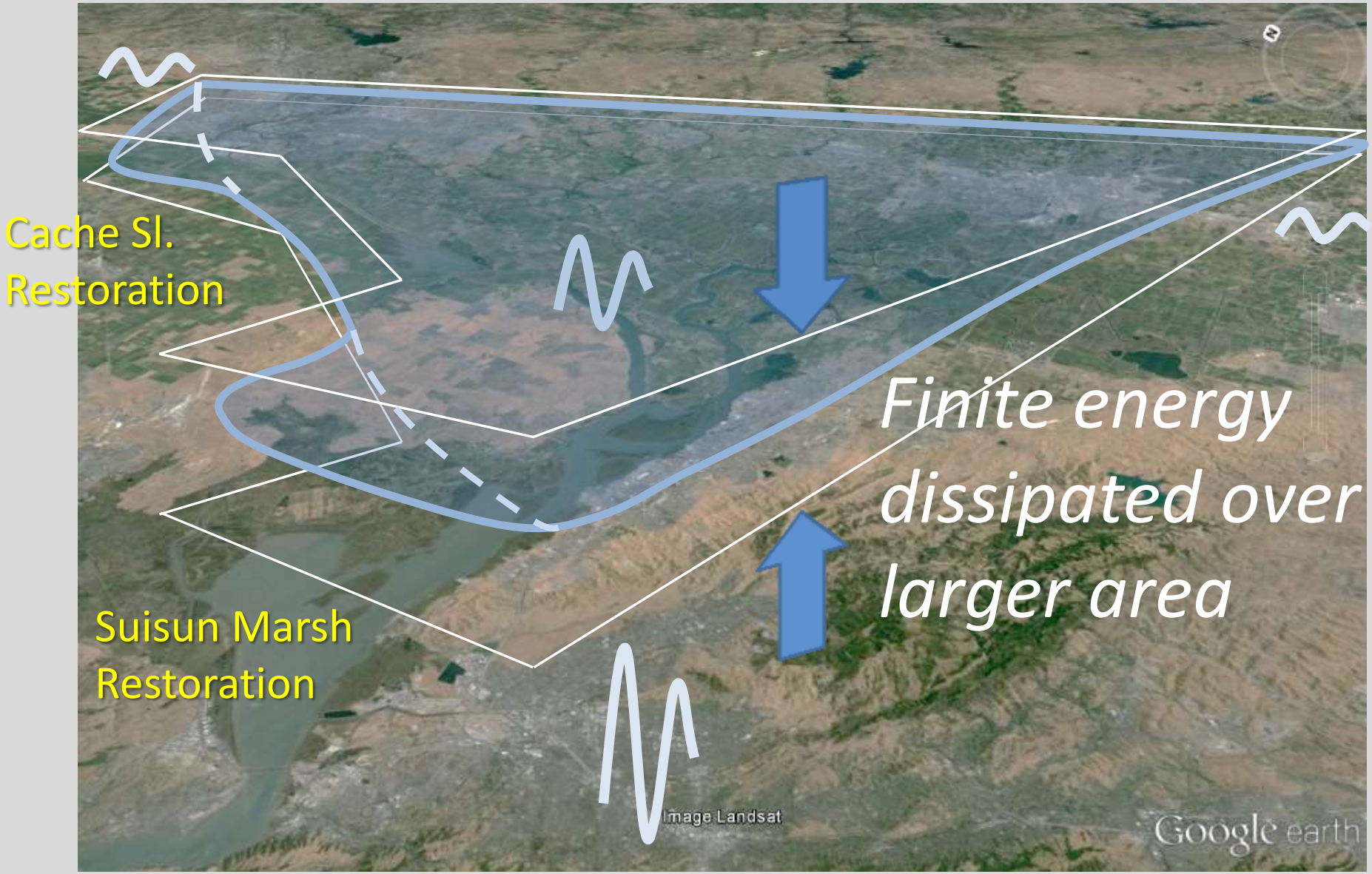

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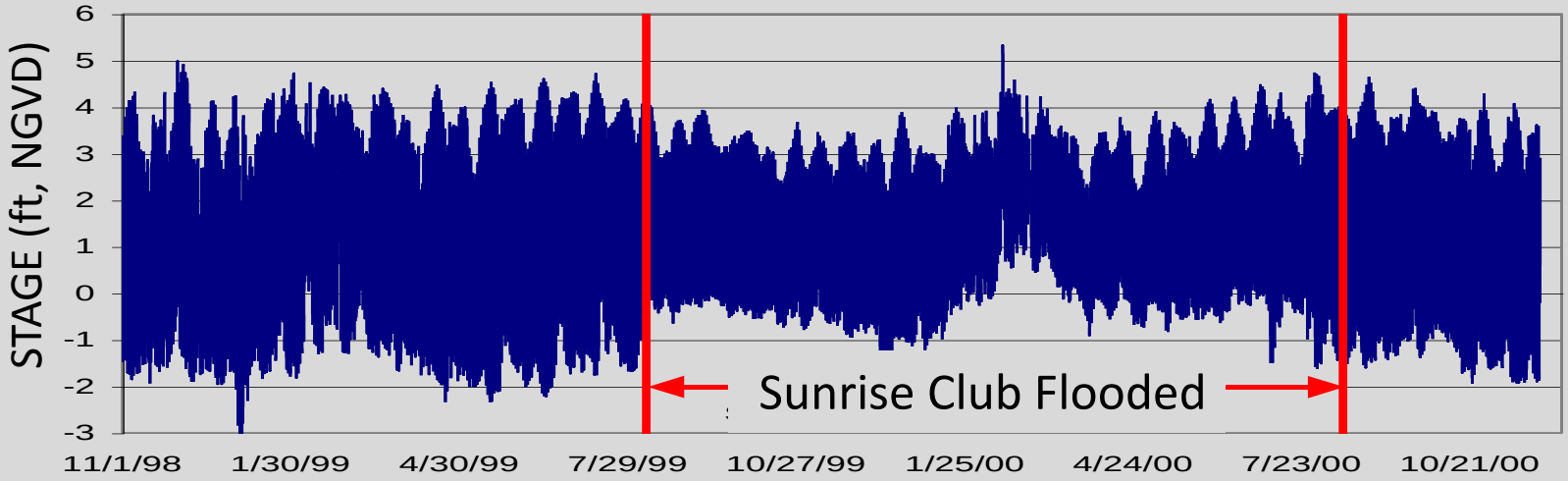

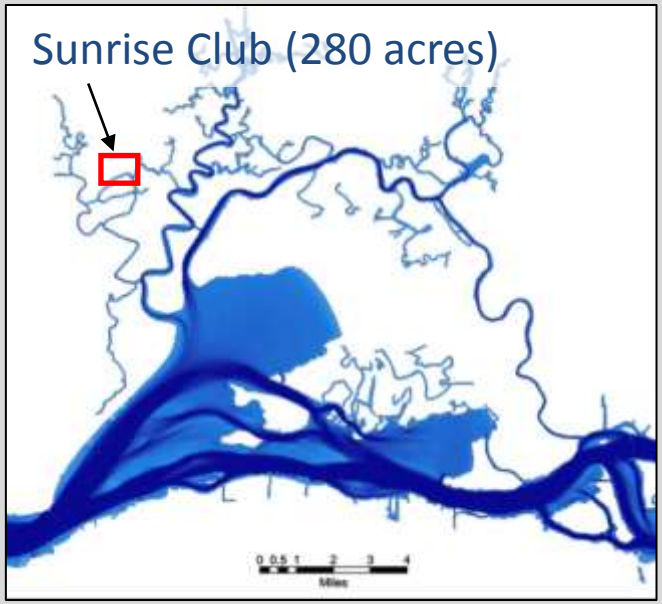

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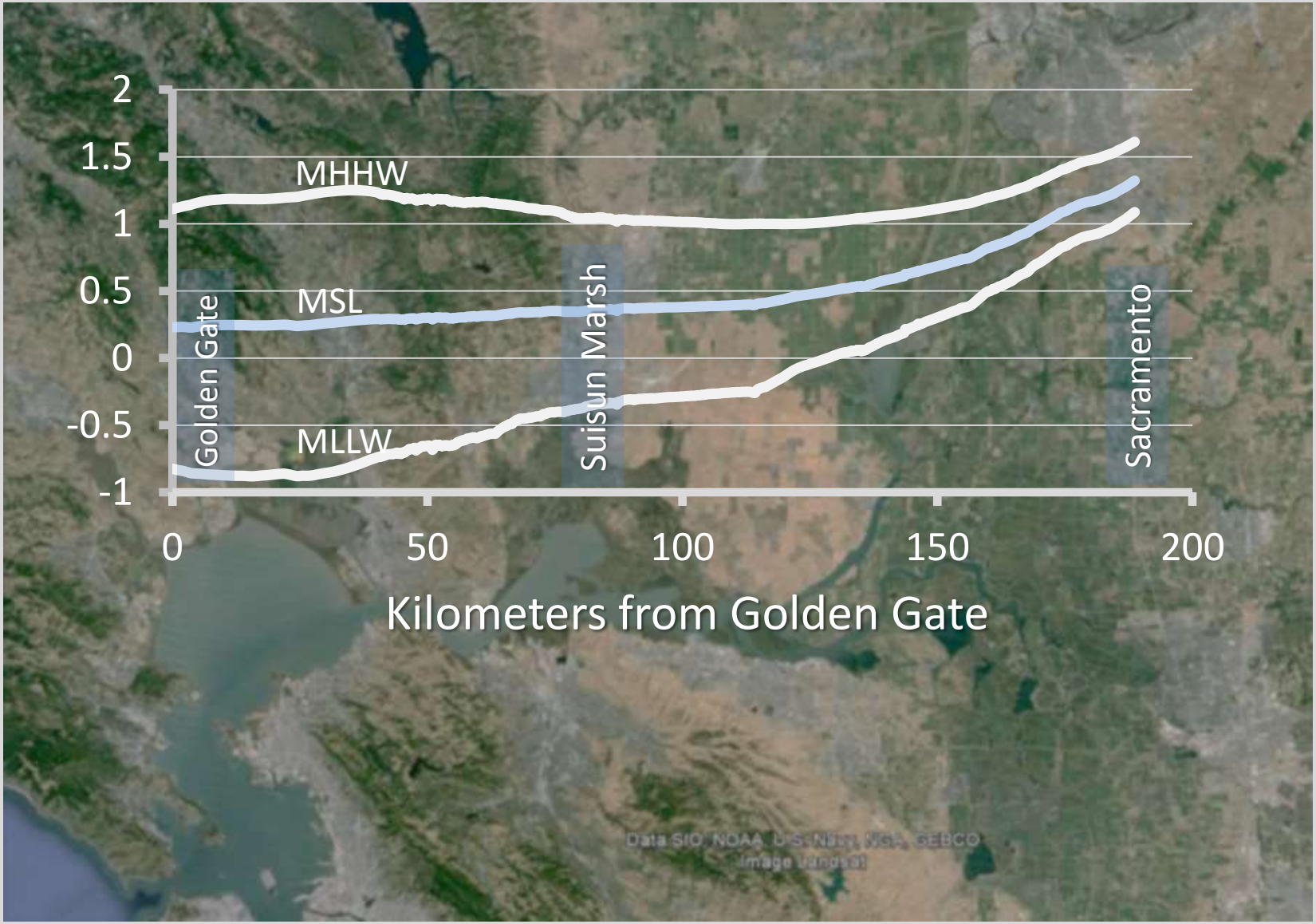
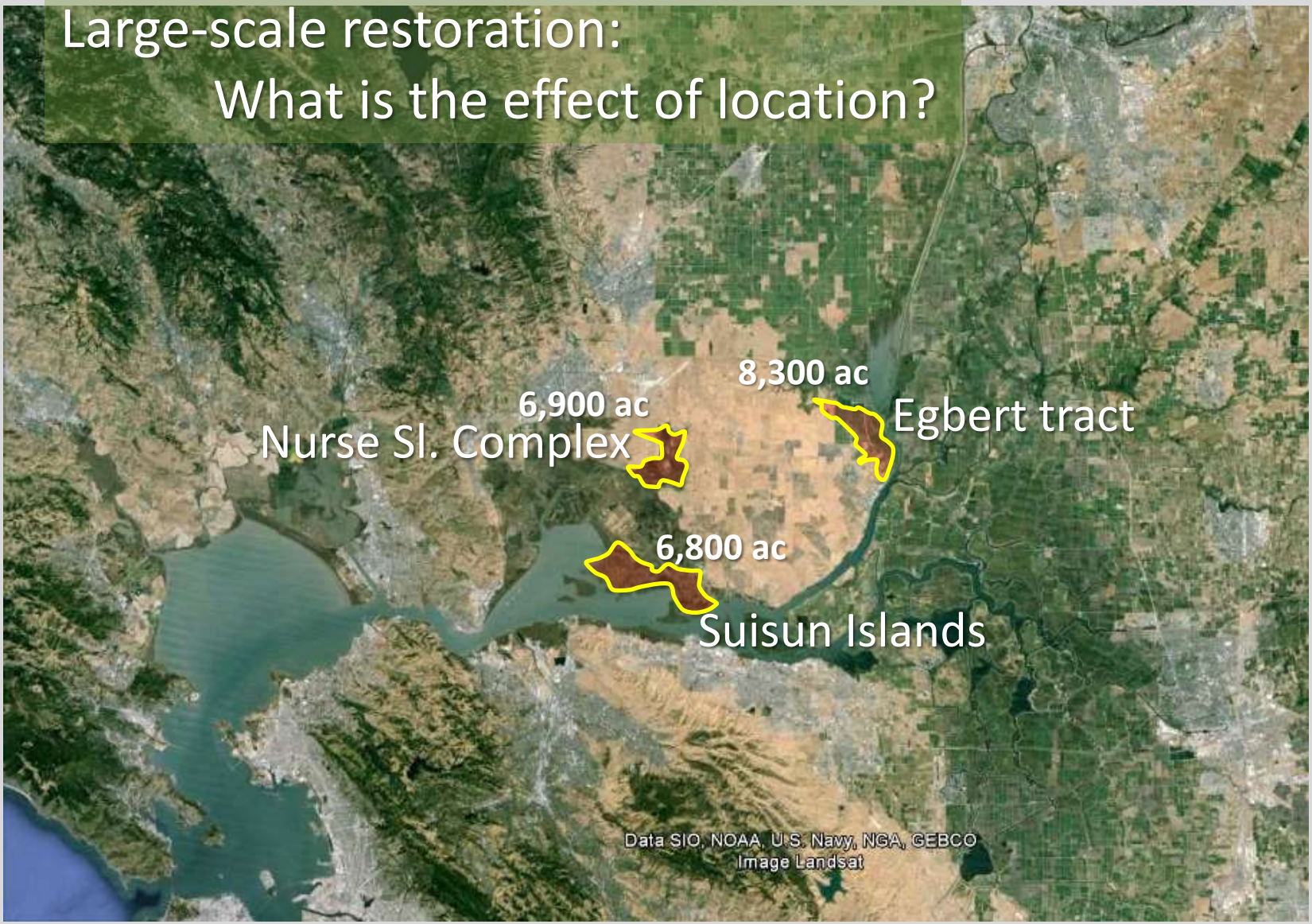


2. Tidal range

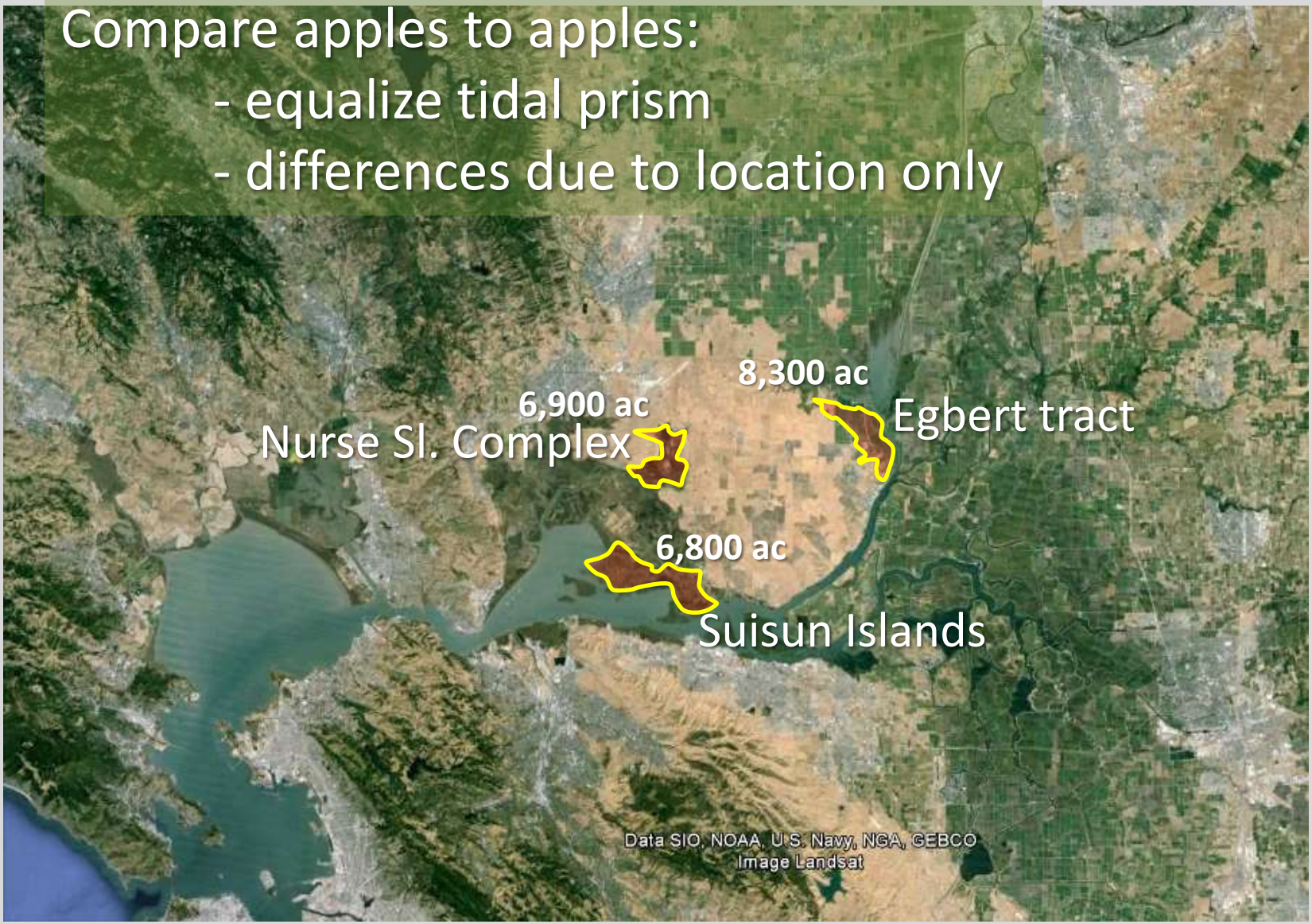
Large-scale restoration:
What is the effect of location?



2. Tidal range

Compare apples to apples:

- equalize tidal prism
- differences due to location only



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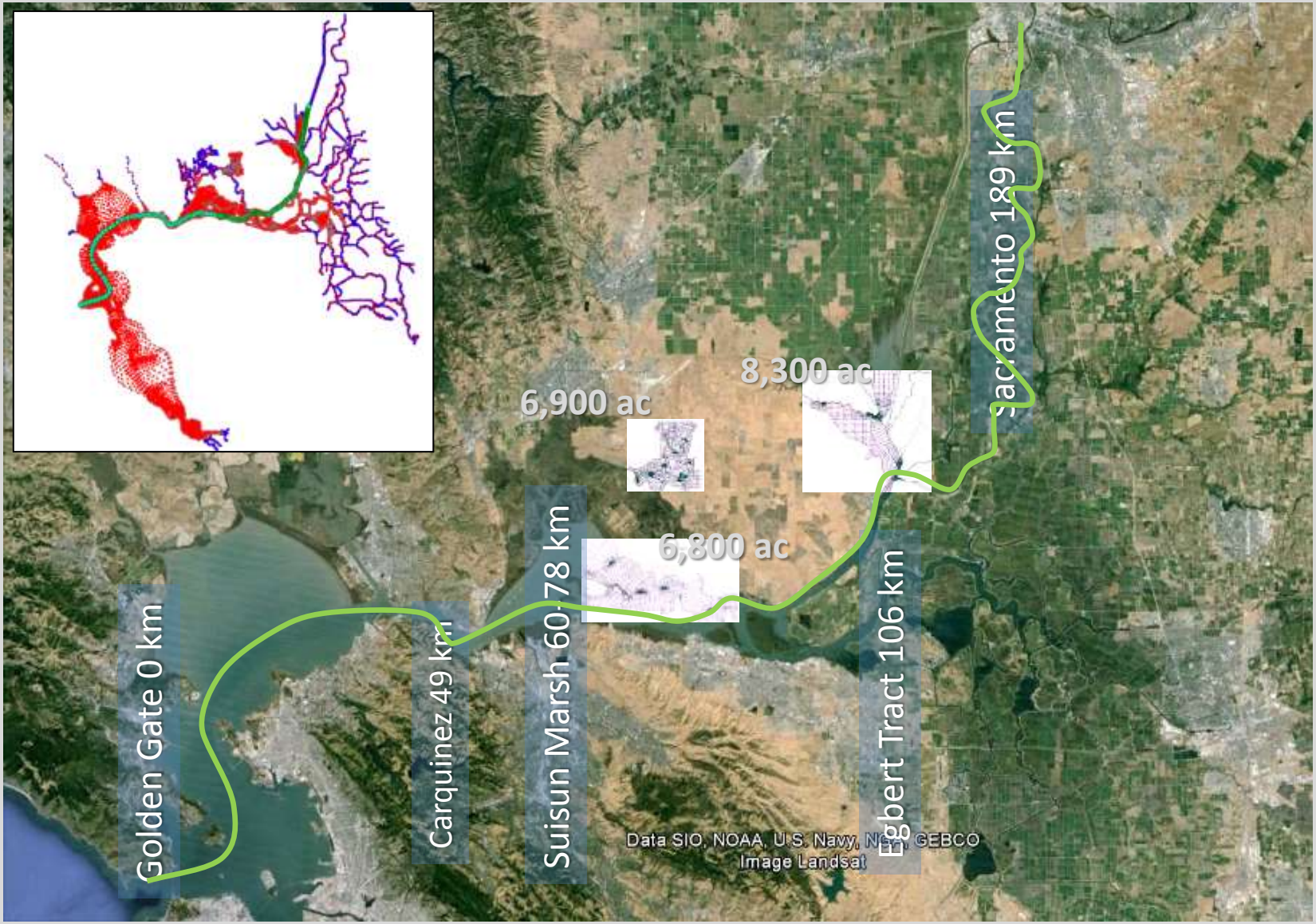

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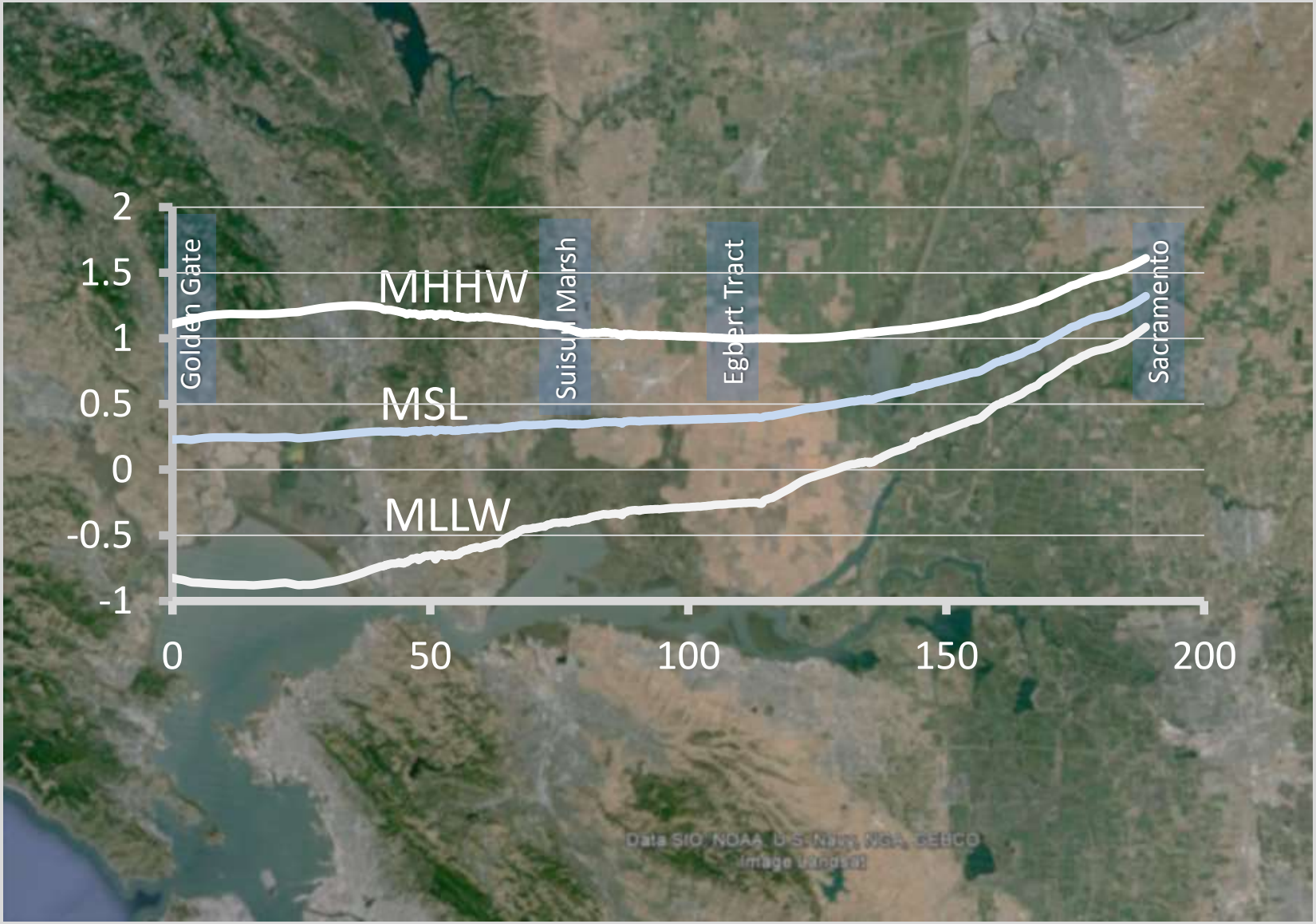

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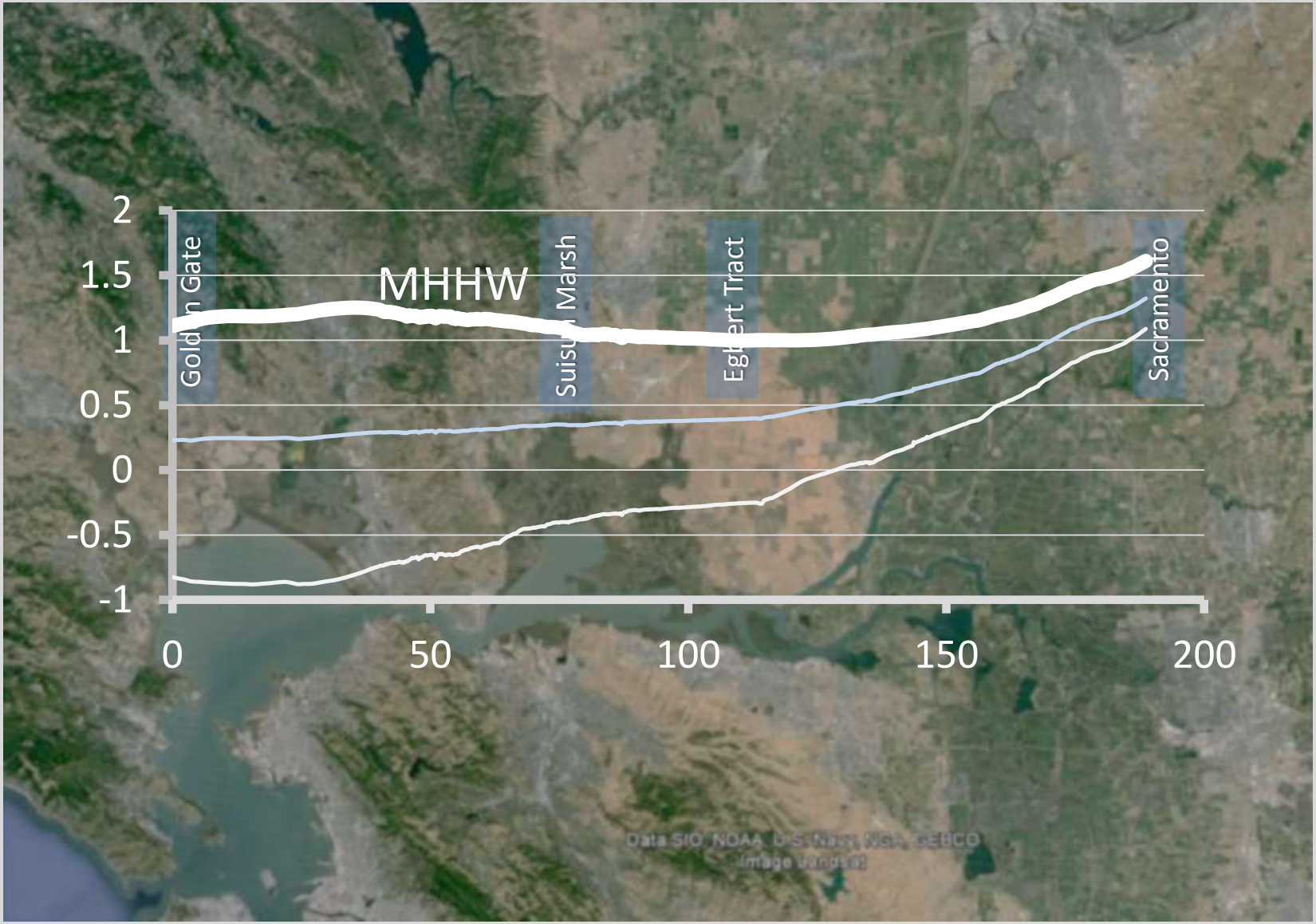

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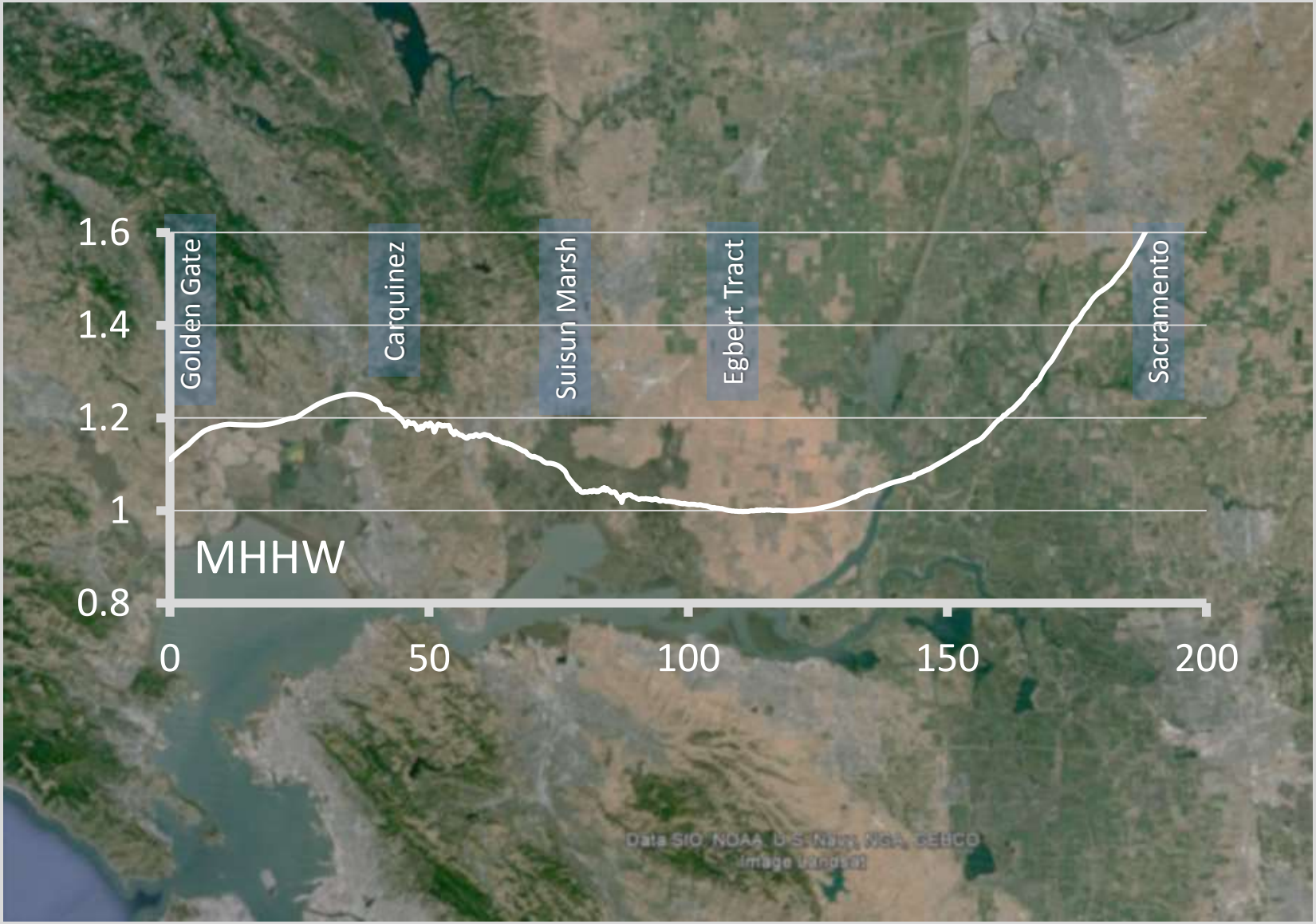

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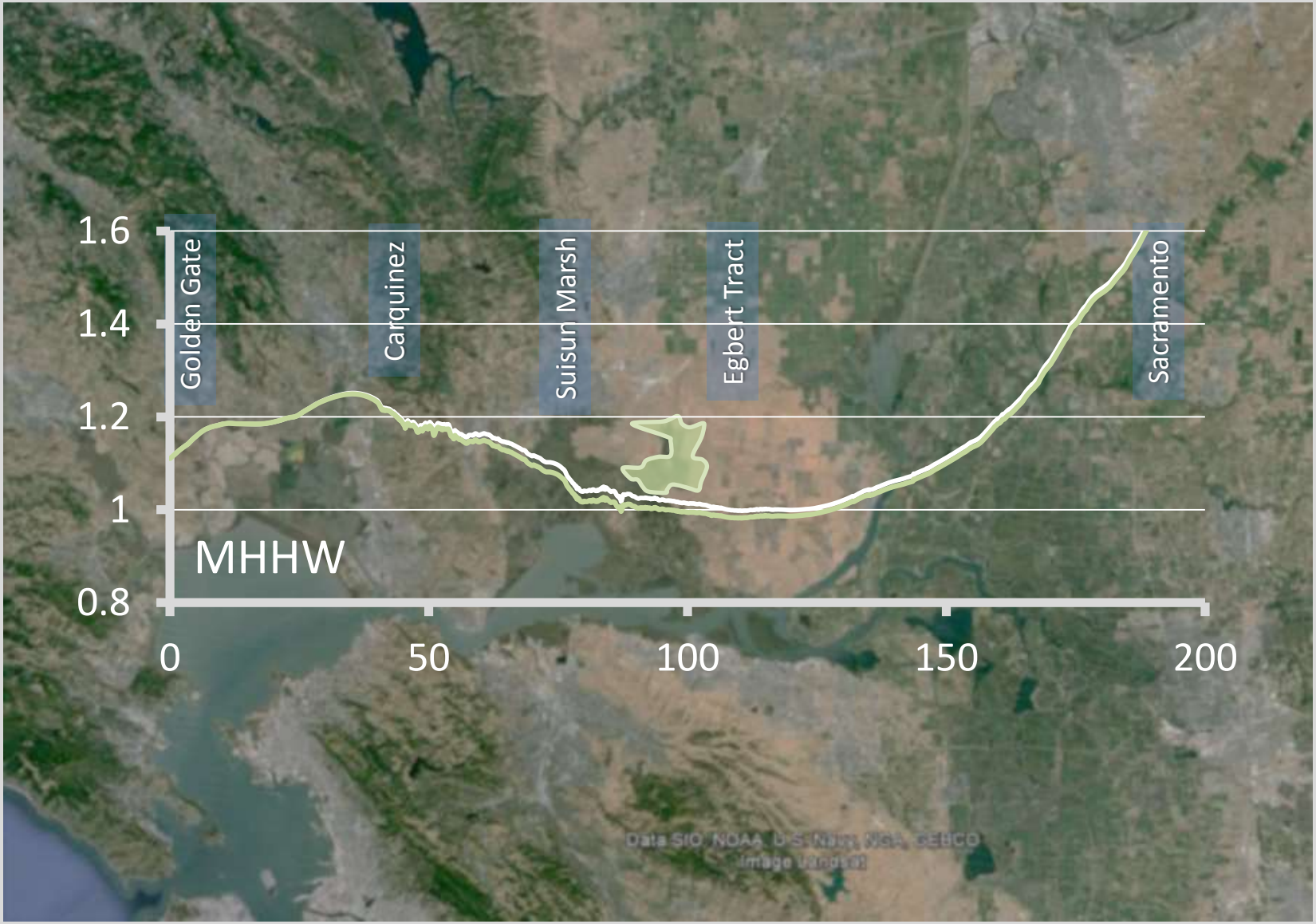

2. Tidal range

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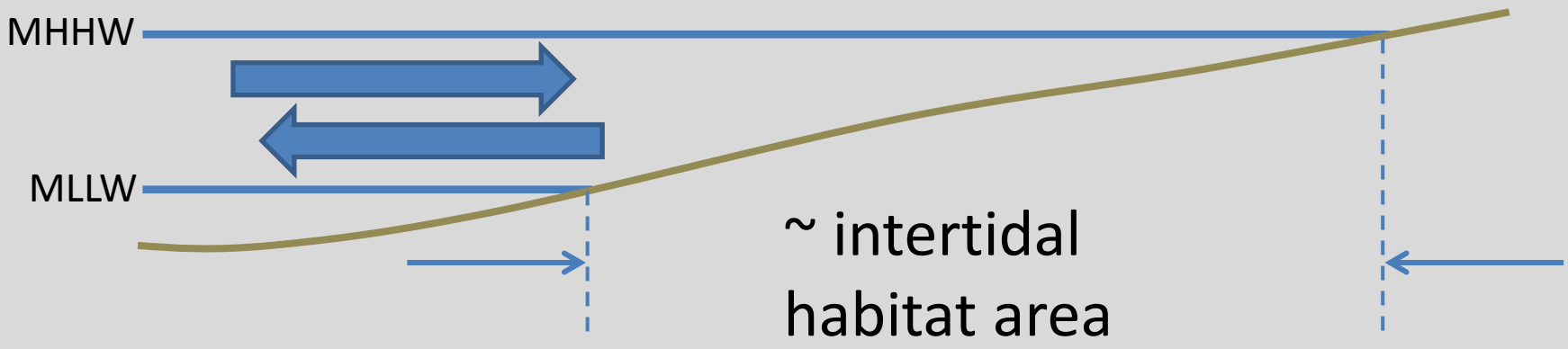
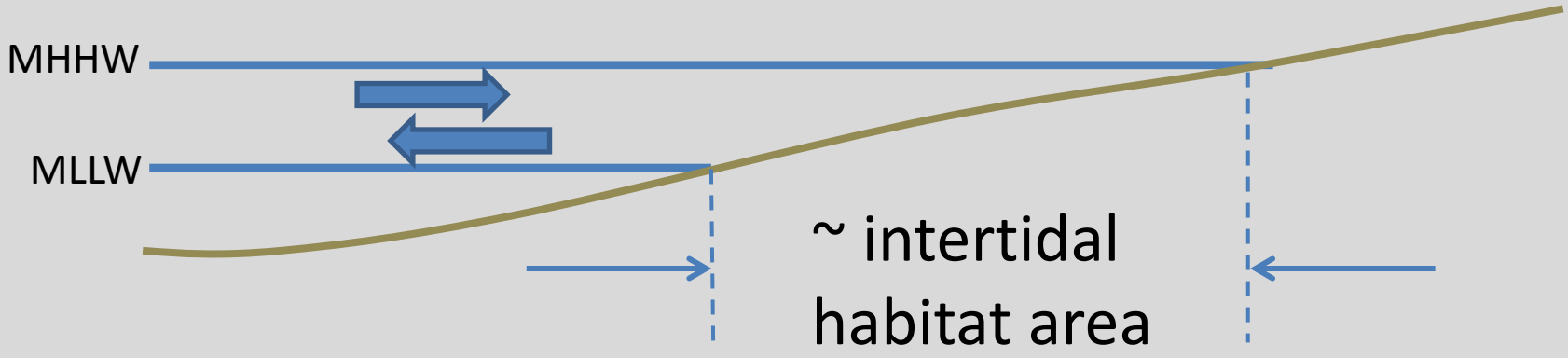
3. Tidal currents

- Tidal currents ~ tidal range



3. Tidal currents

- Tidal currents ~ tidal range
- Overall, expect lower tidal current velocity



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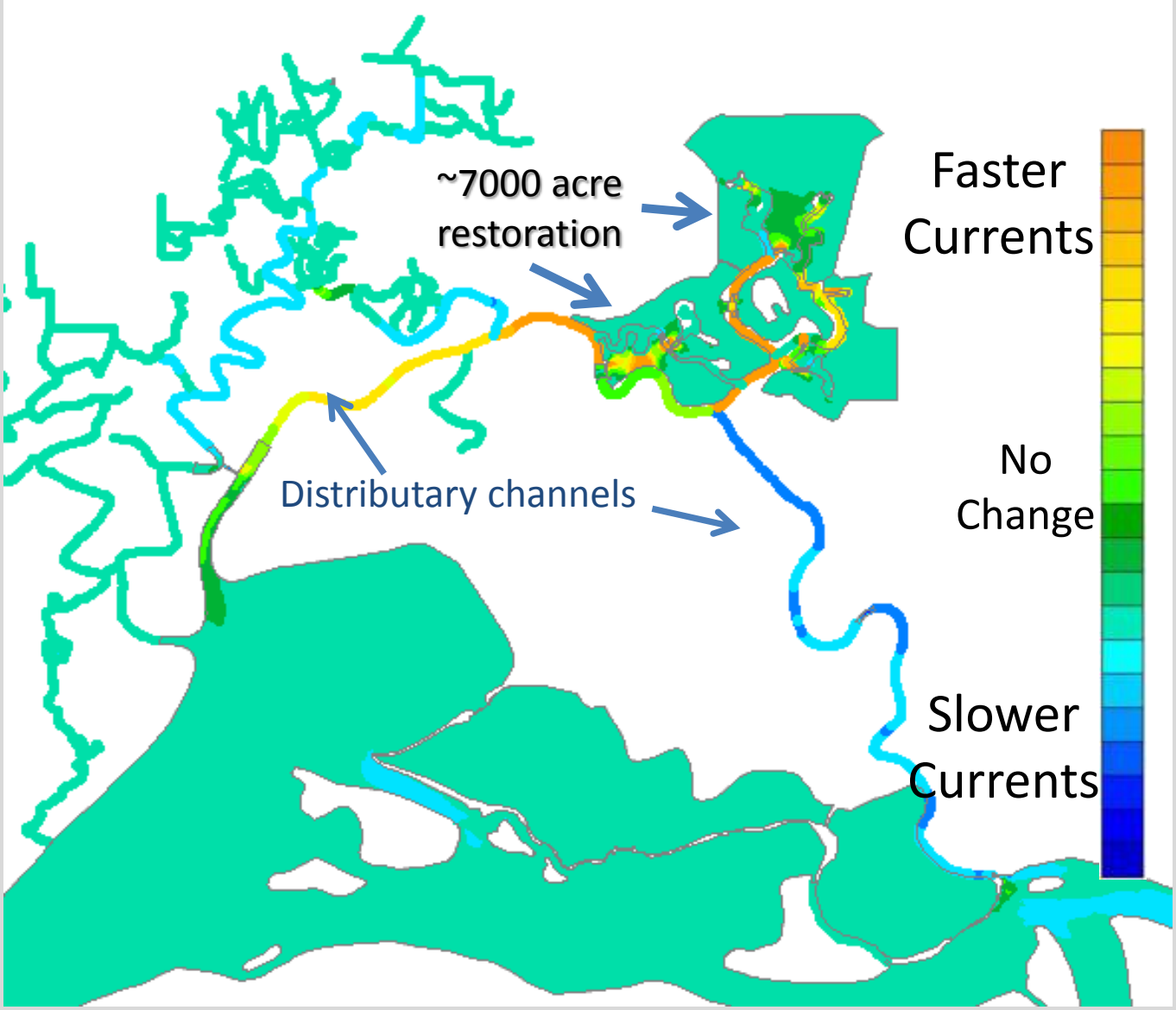
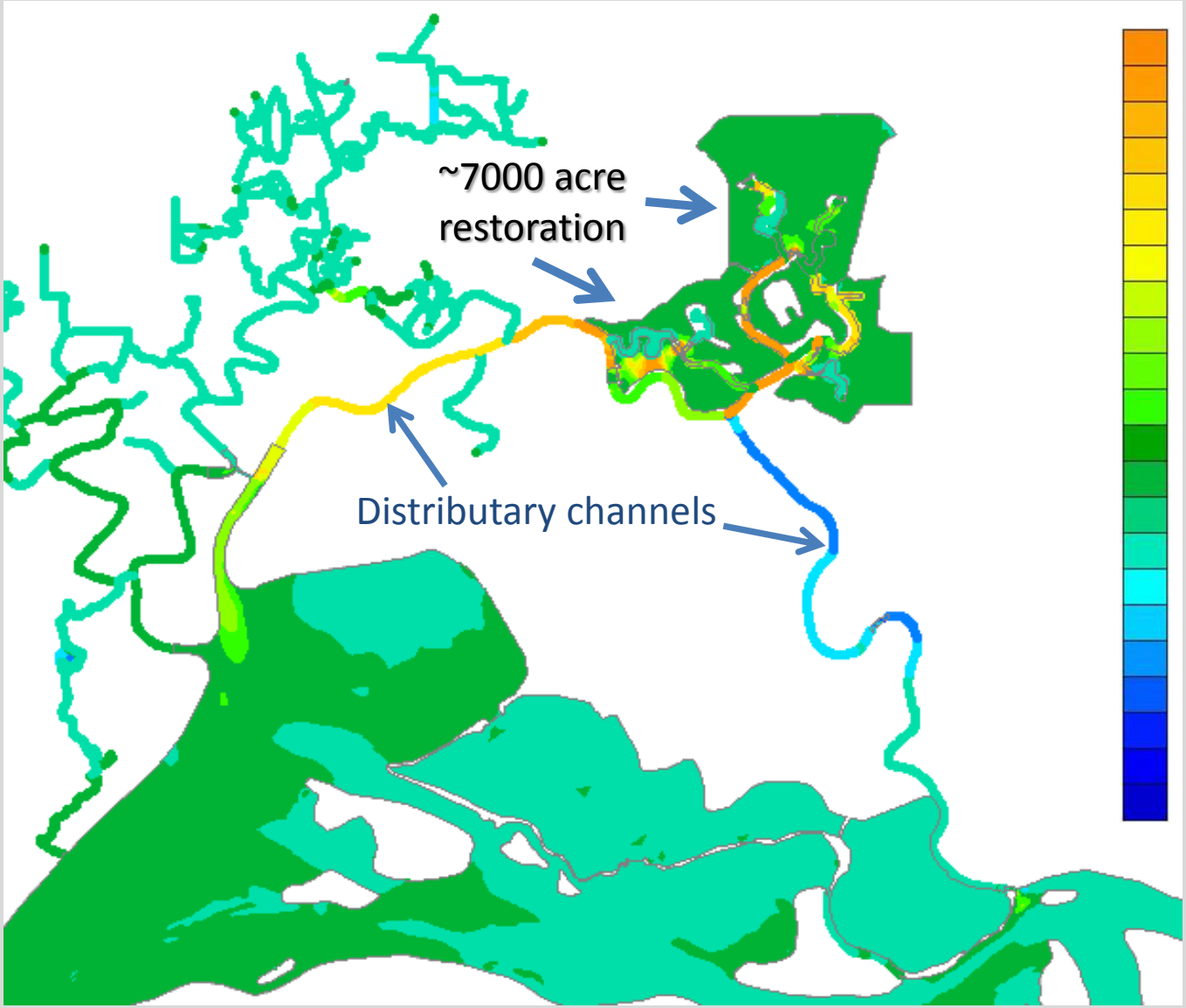


But, currents can increase *a lot* near restorations

4. Bed shear stress

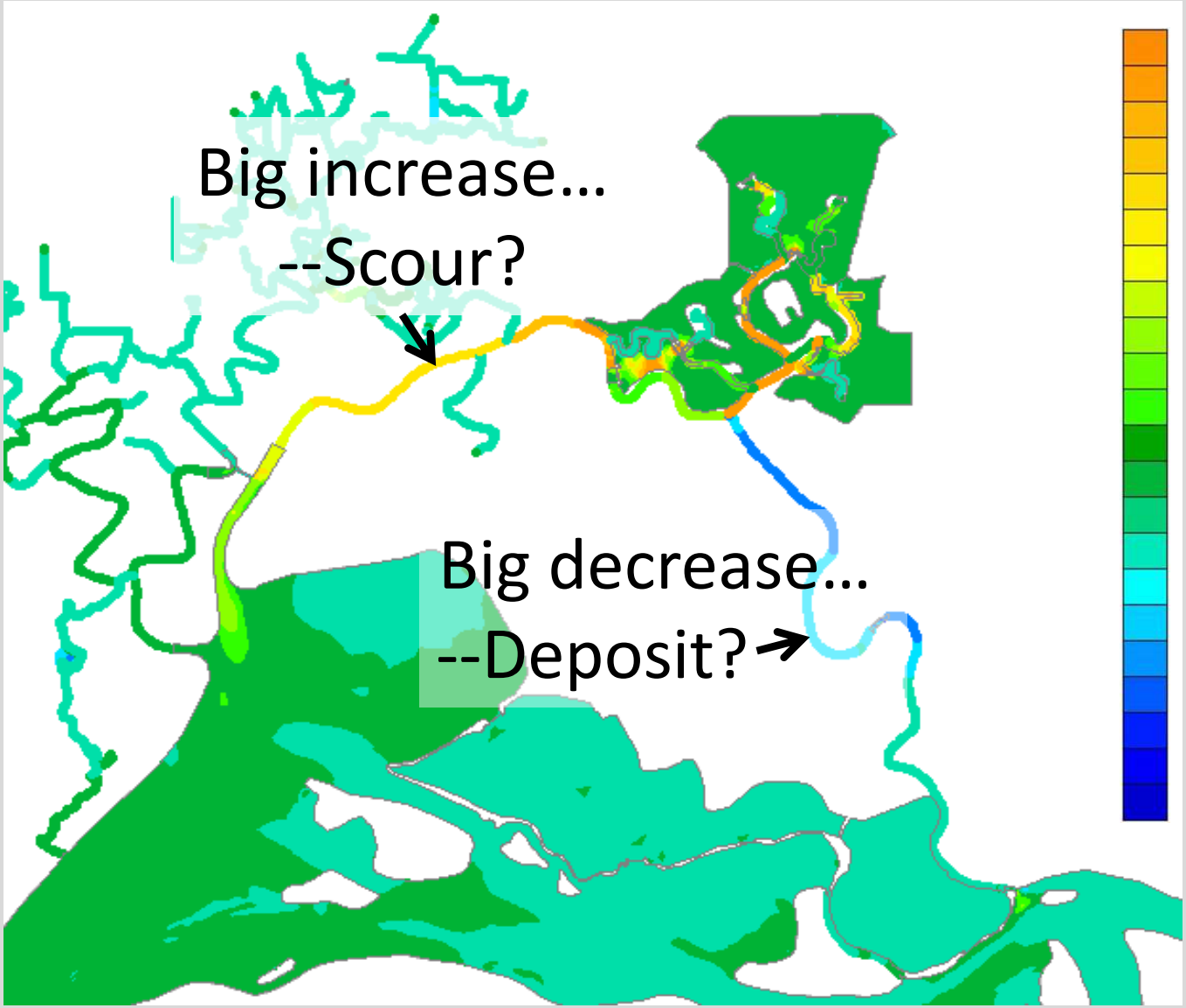


More
Shear stress

No change

Less
Shear stress

4. Bed shear stress



More
Shear stress

No change

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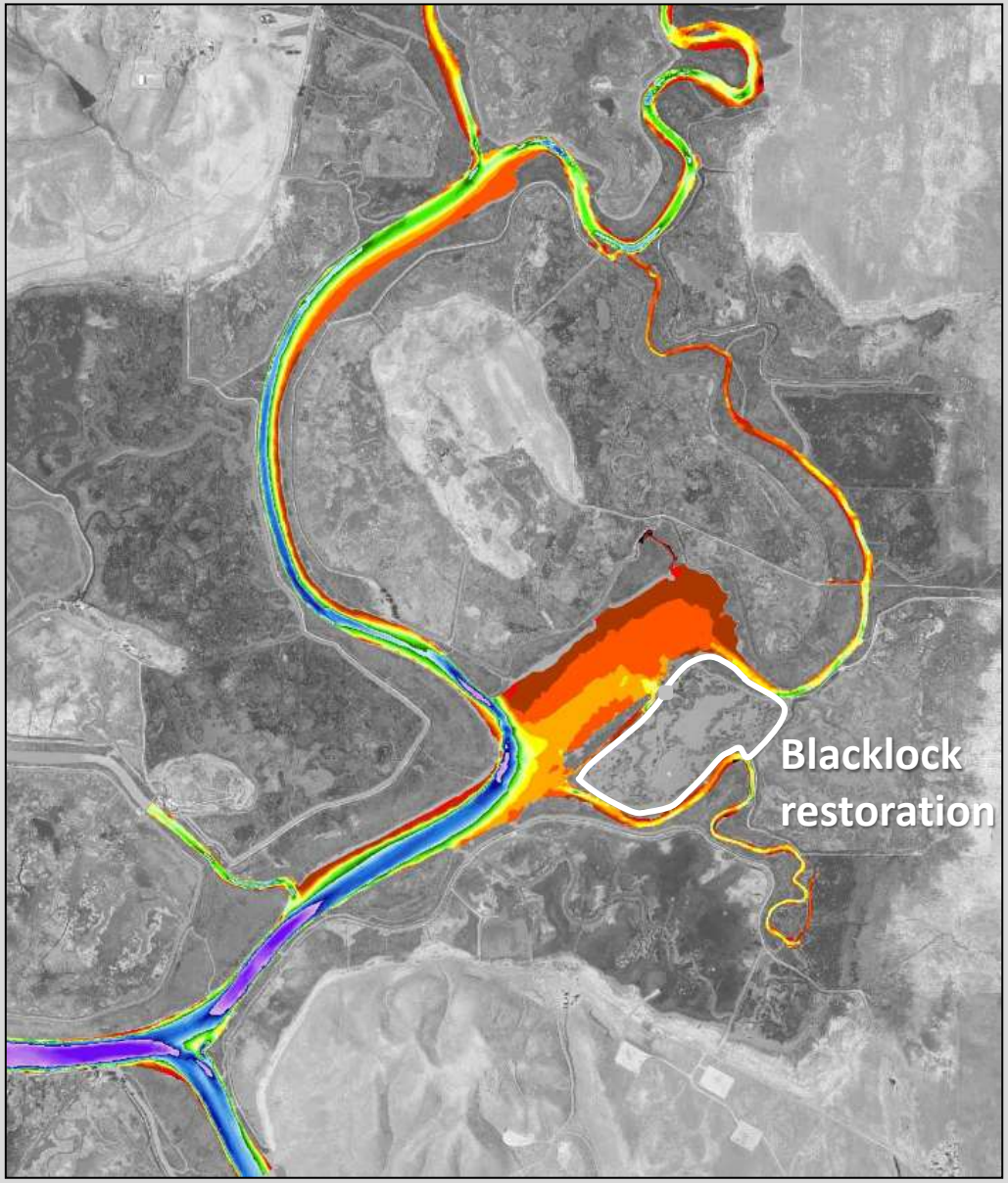
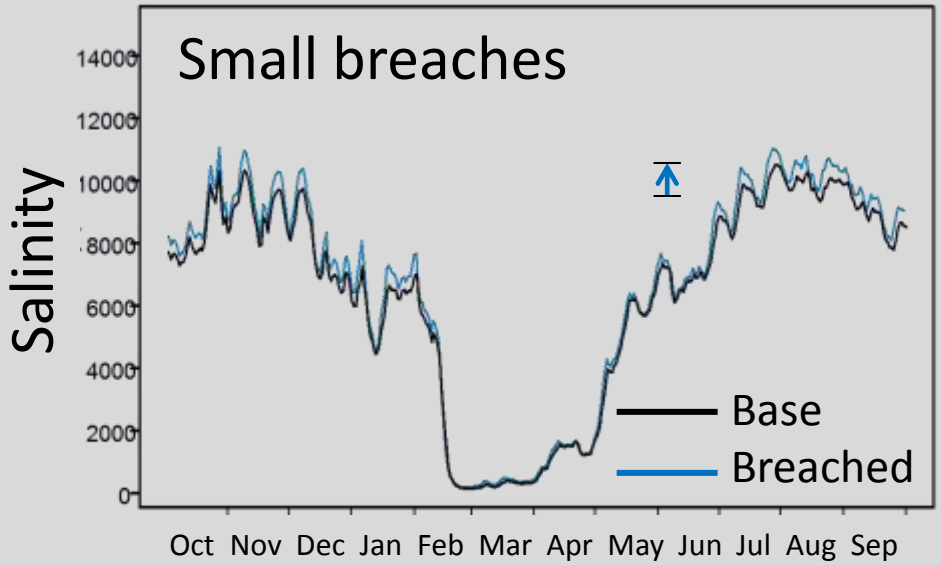
4. Bed shear stress

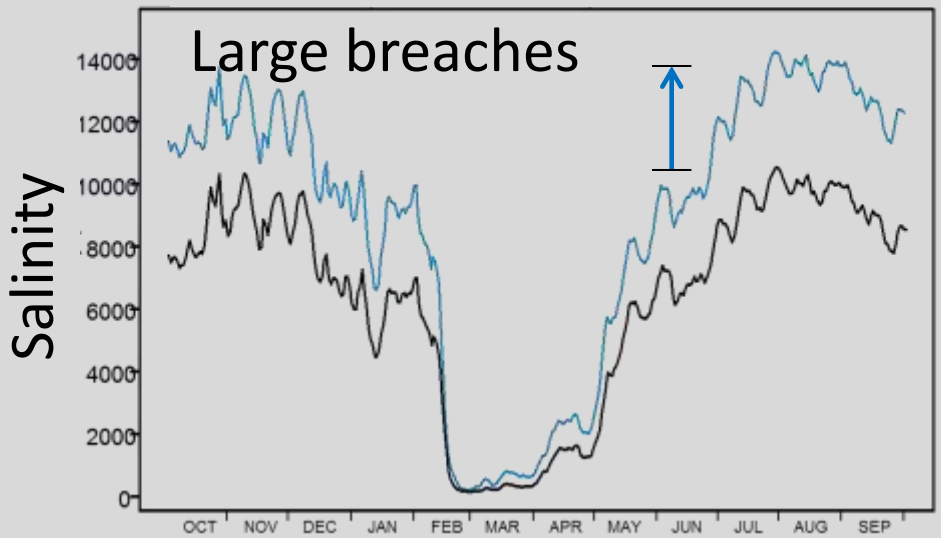
Restorations will change bathymetry--

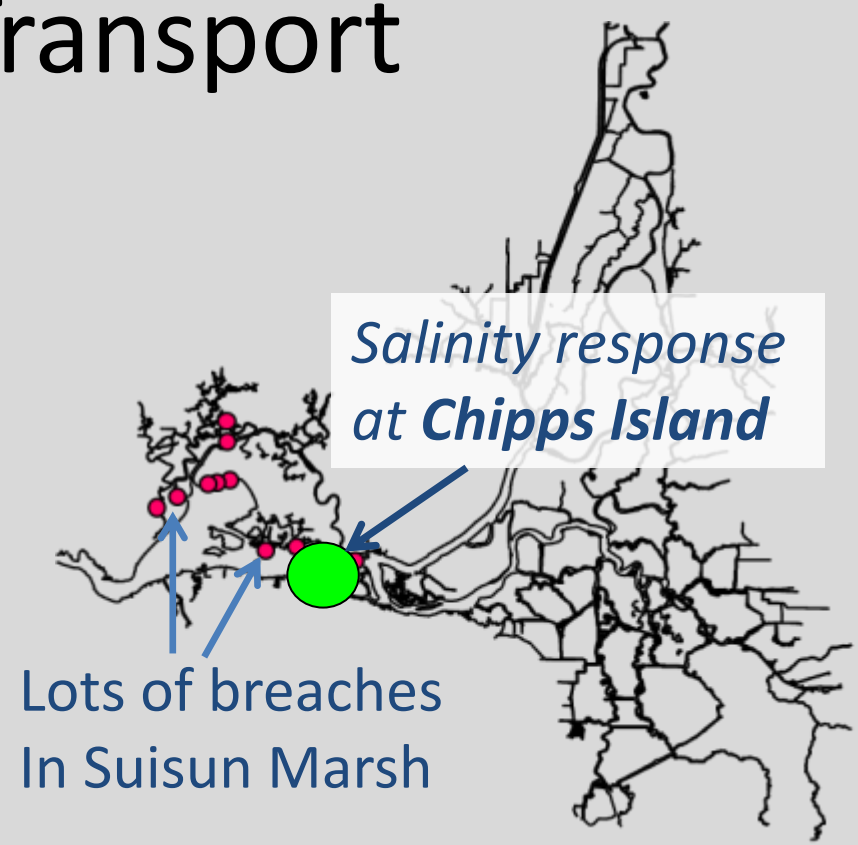
which will change restorations…



5. Scalar Transport







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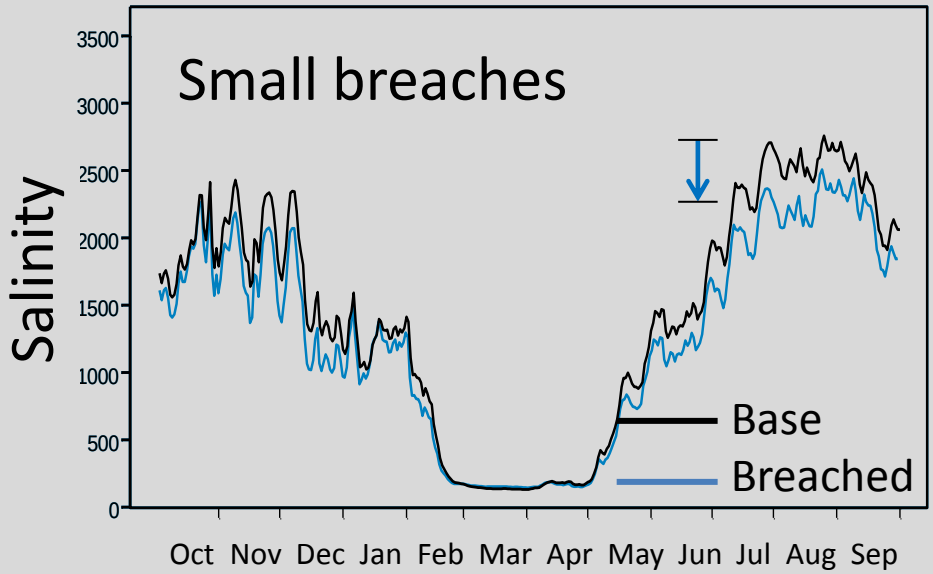

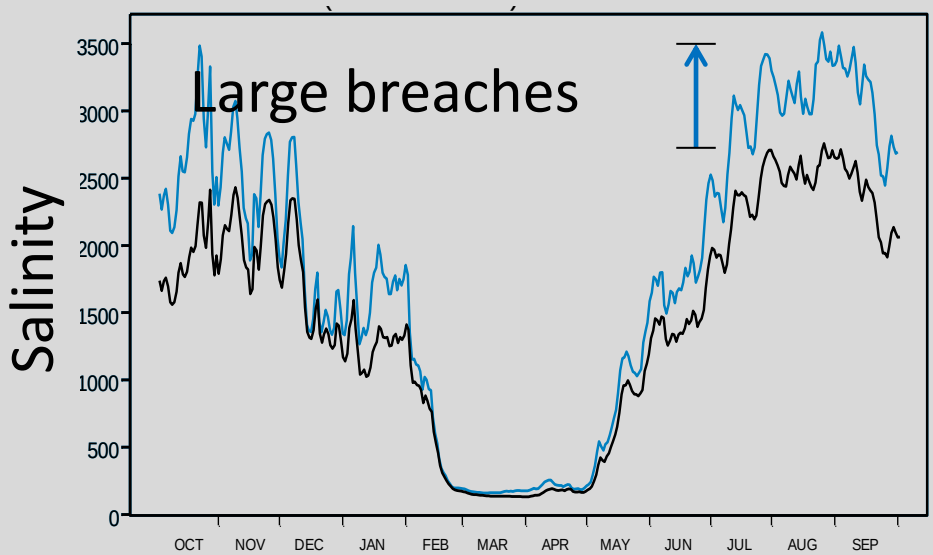

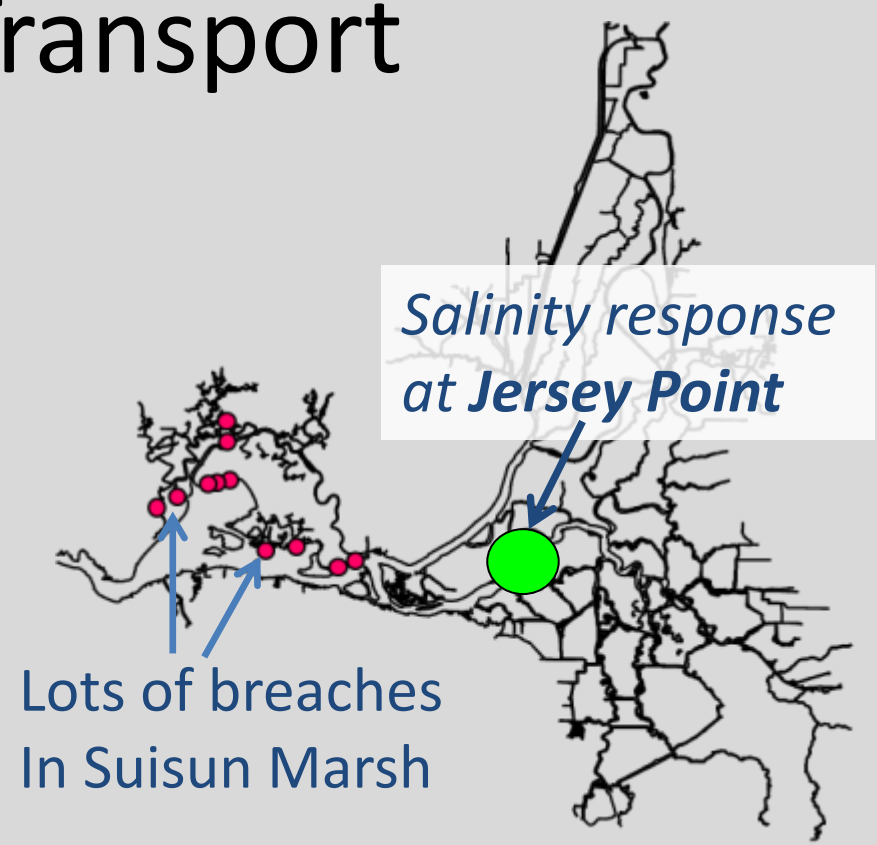

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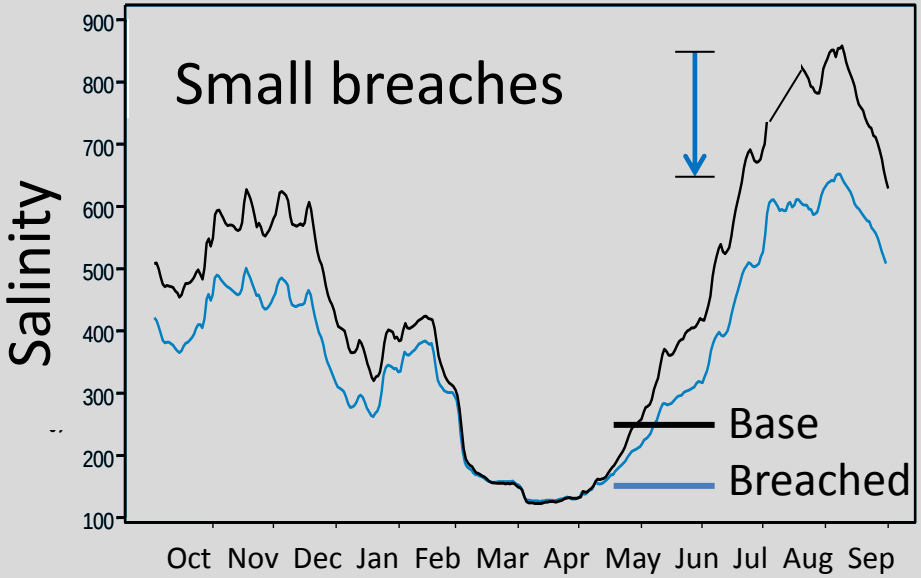

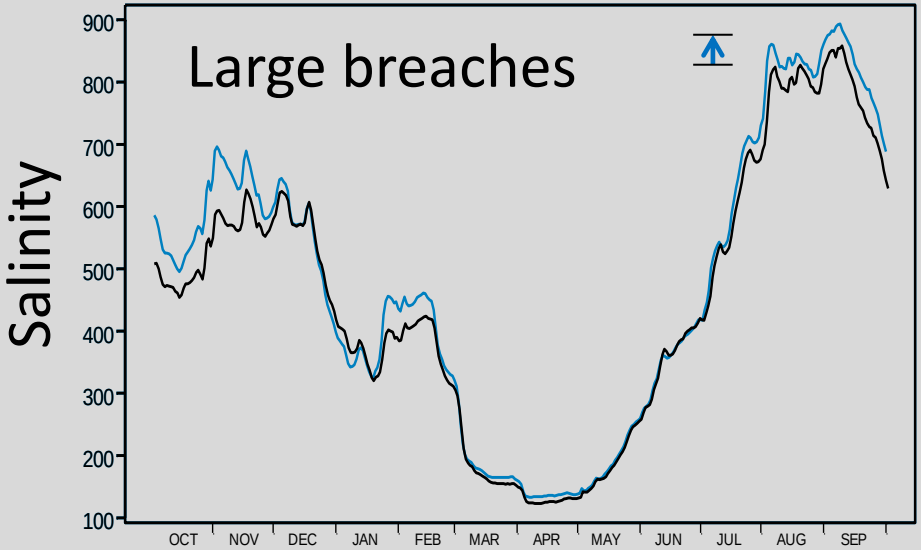

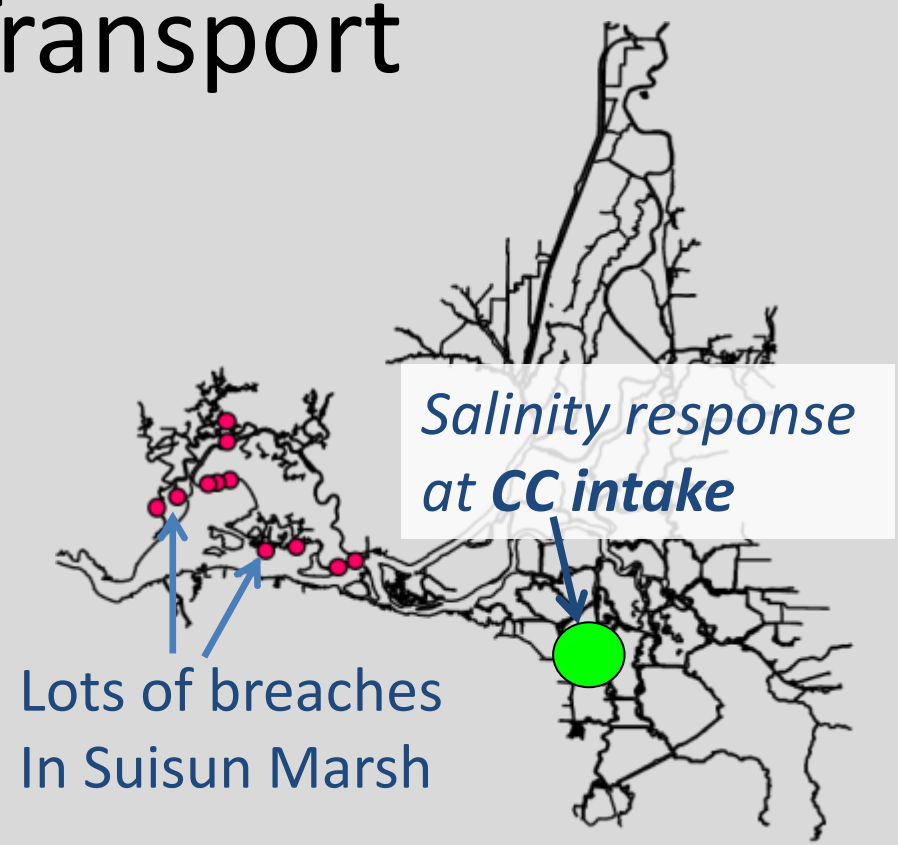

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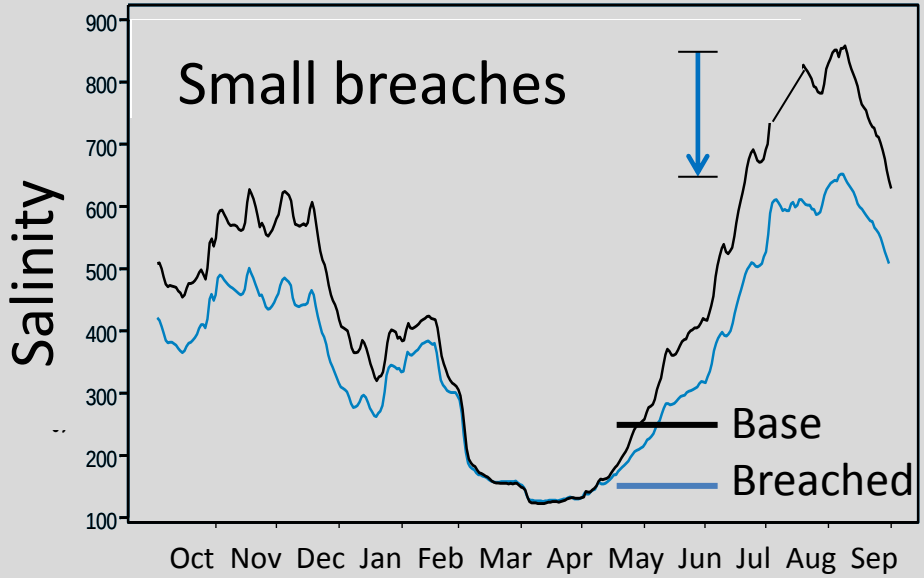
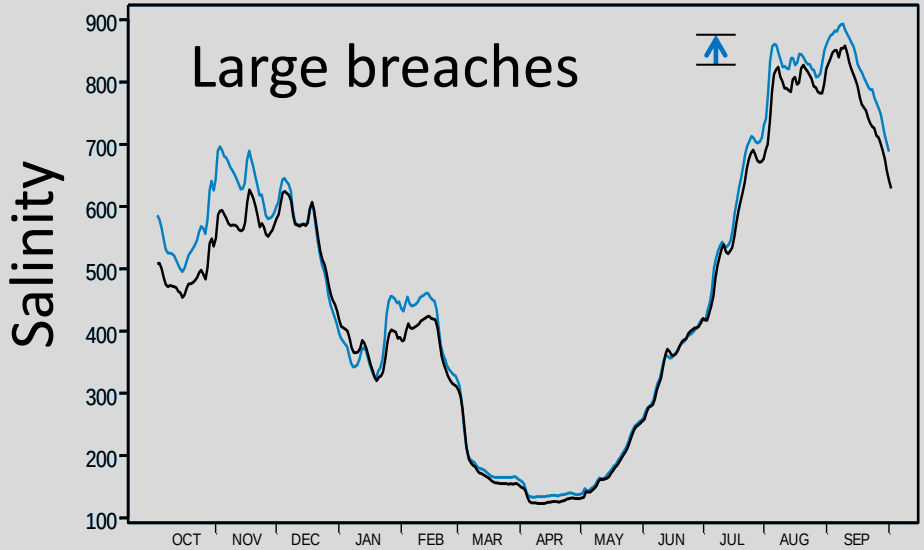
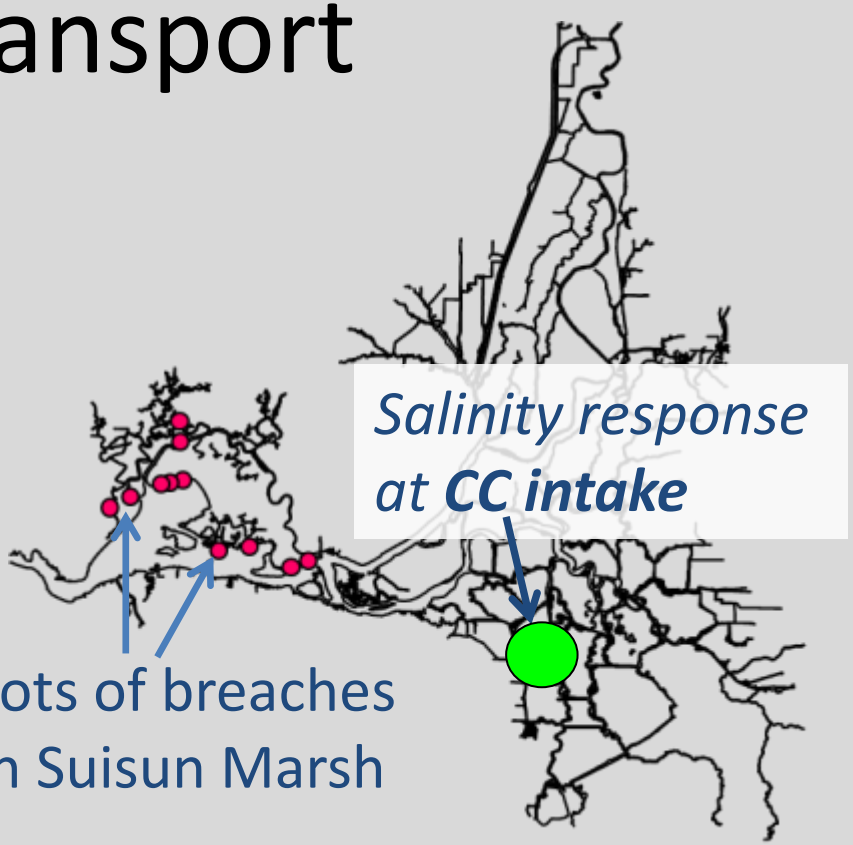






- *Connections matter*
- *Effects are*
  - *complex*
  - *system-wide*
  - *change with time*

Things to know

- Tidal energy is a primary but finite system driver
- Restorations put estuary out of balance--transient
- Connections matter
- Effects are
  - complex
  - system-wide
  - change with time
- Effects on tidal range are nearly additive
- Modeling must consider bathymetry change
- Restoration effects and are affected by restoration

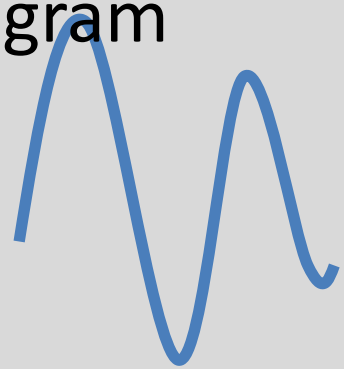
Effects affect the effects

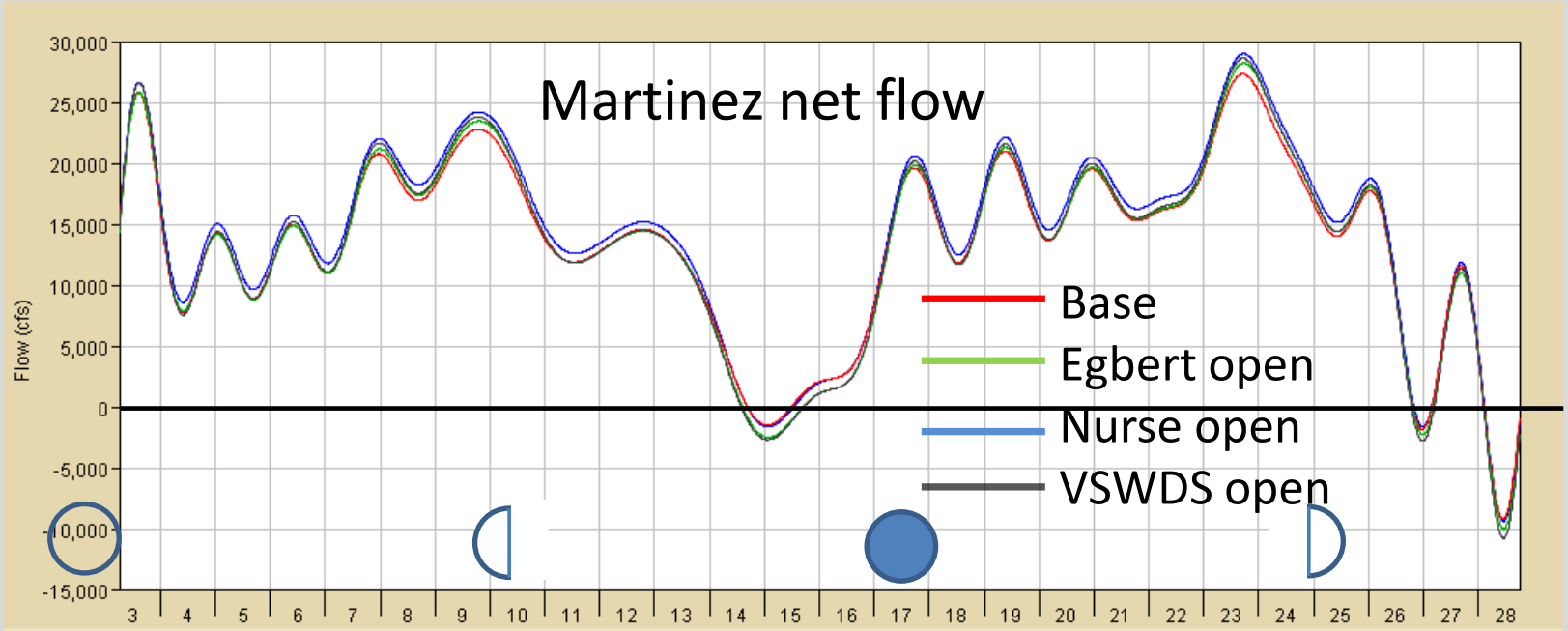
Implications for Science and Mgmt

- Restoration design, scale, and sequence matters
- Invest in restoring elevation and physical processes
- The estuary won't stand still while we monitor progress
- Large-scale restoration requires continuous *adaptive analysis and synthesis* to properly inform management decisions

Thank you

- Steve Culberson
- Jon Burau
- Curt Schmutte
- John DeGeorge
- Brad Tom
- Ed Gross
- Mark Stacy
- The cool people and the Delta Science Program
- Mom





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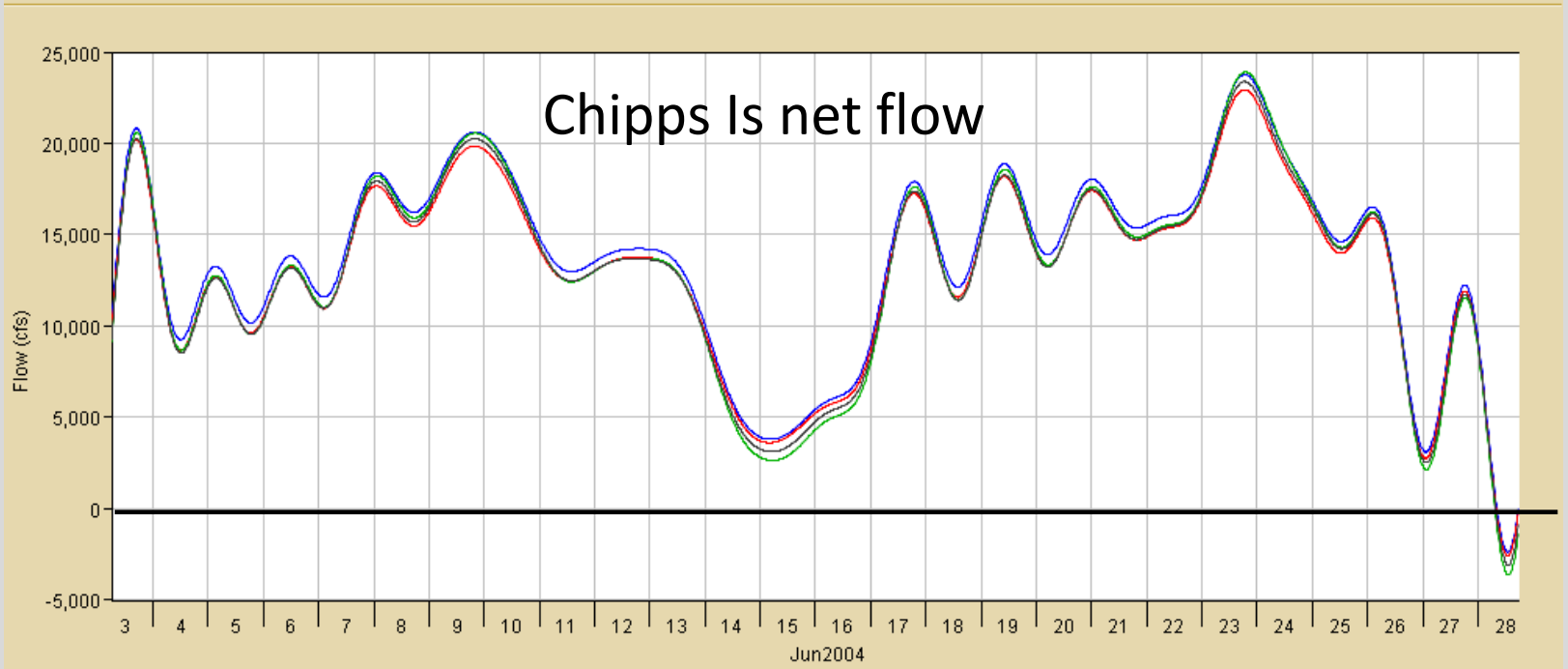

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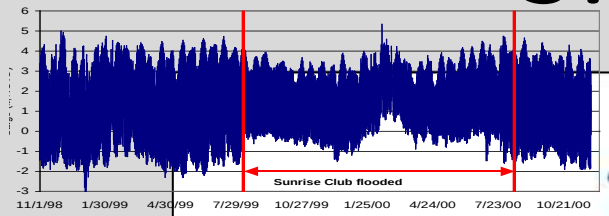
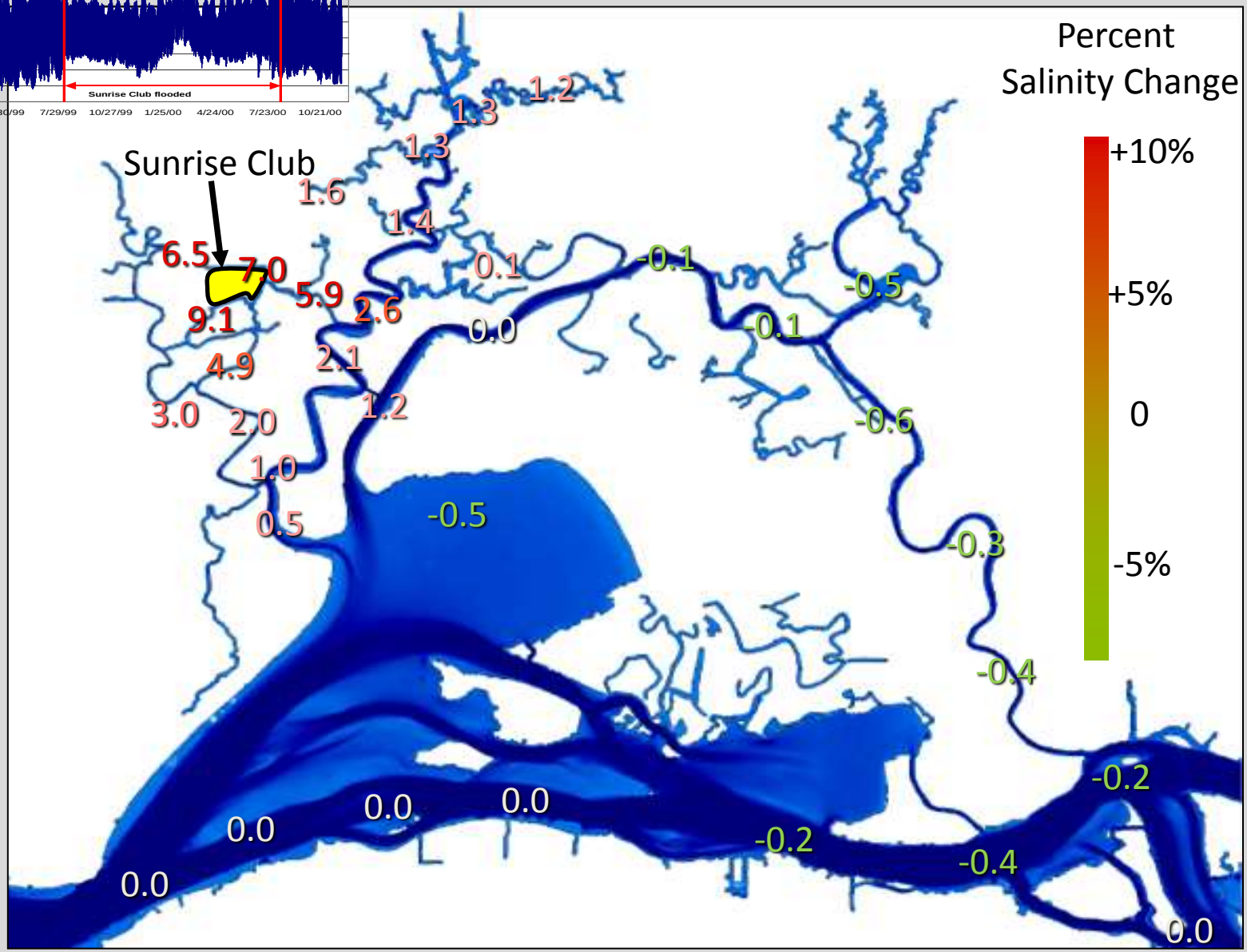
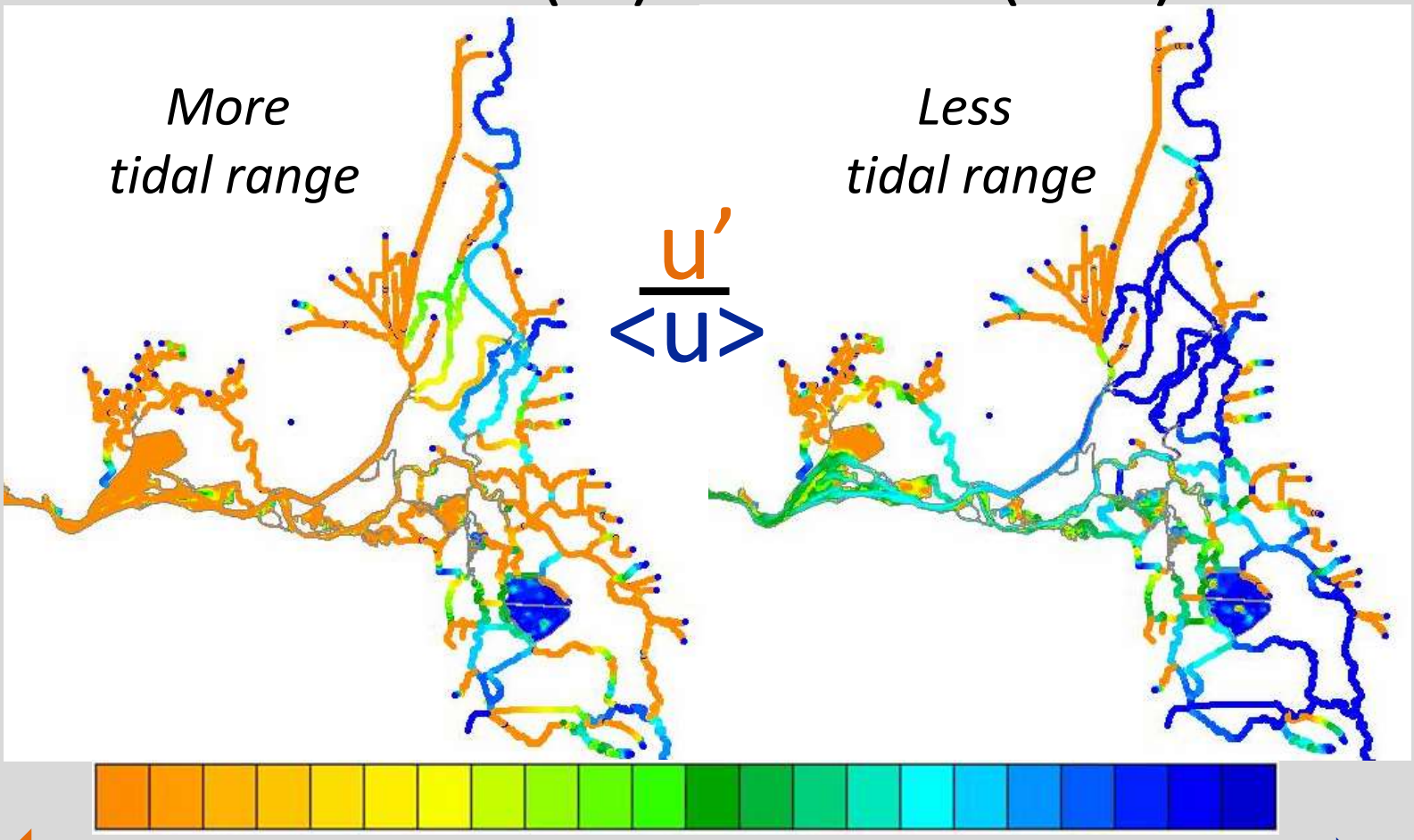




3. Tidal currents

Ratio of tidal (u’) to fluvial (<u>) flow



More tidal

More fluvial