Terrestrial Sediment Flux Across a Fringing Reef in Moloka'i, Hawai'i

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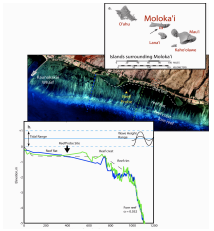
ABSTRACT

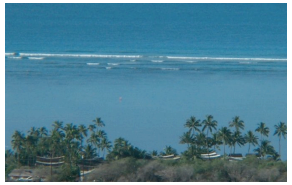
In environments with fringing reefs, terrestrial sediment must pass across the reef in order to reach its ultimate sink. While on the reef, this sediment can increase coral stress. Sediment particles that settle on coral interfere with photosynthesis and feeding while turbidity resulting from suspended sediment decreases incident light levels. As an example of processes in this type of environment, we present suspended sediment concentration (SSC) and sediment flux data from measurements taken on a fringing reef off south-central Moloka'i, Hawai'i. Terrestrial sediment enters this reef via an eroding gulch just east of our study area. In spring of 2005, 2007, and 2010 seasonal trade winds were the primary driver for resuspension and advecting sediment along and across the reef. These currents were generally westward alongshore with a smaller offshore component. SSC was highest at the easternmost transect (proximal to the deltaic source of sediment) and decreased to nearly half at 4.5 km westward along the reef flat. In addition, a clear concentration gradient was evident as we moved offshore; SSC was highest on the reef flat near shore and decreased towards the reef crest. In the absence of trade winds, for example in spring of 2009, tides were the main driver of currents on the reef. These tidal currents were weaker and had less uniformity in direction than those generated by trade winds. In these conditions, SSC levels were significantly lower but still had the same characteristic of highest concentrations onshore and to the east. These data allow us to assess terms in the sediment budget over a period of time under which management practices have attempted to reduce terrestrial sediment to the reef. These data do not show a clear effect of these practices on the reef. While terrestrial sediment delivery rates may have been reduced, previous high rates created accumulated storage in deltaic deposits that continue to be resuspended by waves and currents and redistributed along and across the reef.

STUDY SITE & METHODS



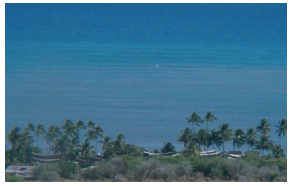
Backpack

Instrument	Height above bed
Electromagnetic Current Meter	20 cm
Pressure Sensor	50 cm
Optical Backscatter Sensors	20, 90 cm
Transmissometer	70 cm
Conductivity and Temperature Sensor	profiling



Low Tides: waves break on the reef crest, resuspended sediment on the reef are low.

Low Winds: Little resuspended sediment visible on reef flat.



High Tides: waves propagate over reef crest and some suspended sediment visible on reef flat.

High Winds: significant resuspension of sediment clearly visible on reef crest

ACKNOWLEDGEMENTS

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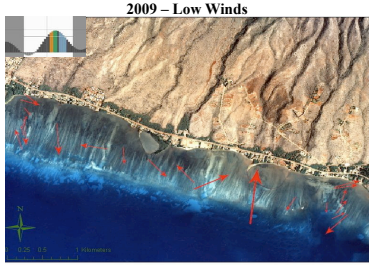
CURRENT DIRECTION AND MAGNITUDE

2010 – Typical Trade Winds

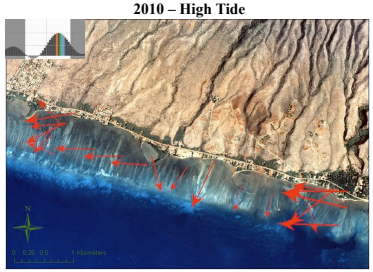
In typical spring trade wind conditions, currents are relatively stronger and well organized along shore with an offshore component.

2009 – Low Winds



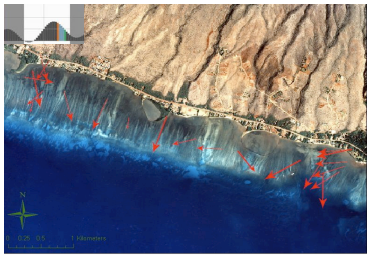
In 2009 winds were atypically weak. Resulting currents were correspondingly weaker and less well organized.

2010 – High Tide



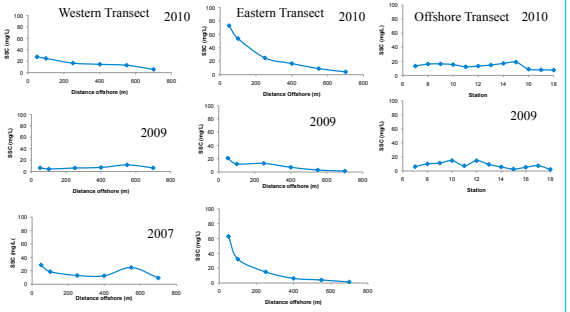
Currents are stronger and more organized along shore in high tide conditions.

2010 – Ebb Tide



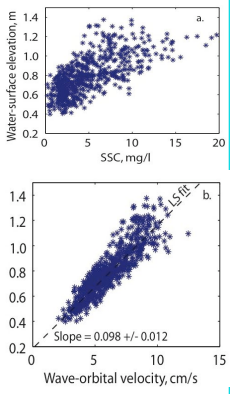
Currents during ebb tide are weaker but still relatively well organized along shore.

SUSPENDED SEDIMENT CONCENTRATION

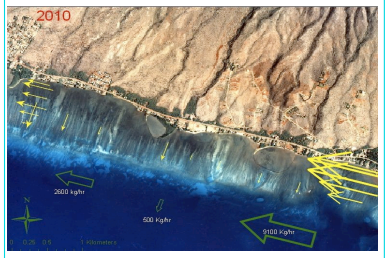


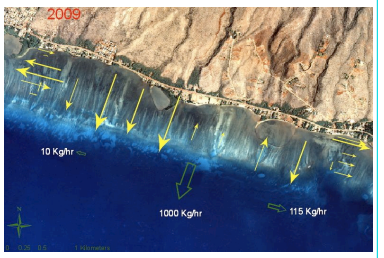
• Highest concentrations observed in all cases at the eastern transect. This transect is located close to the Kawela Gulch, a major channel for flood waters from the uplands.
• 2010 and 2007 are relatively similar in sediment concentration indicating little change over time.
• 2009 shows effects of decreased winds. SSC is approximately 3 – 4 times lower than years with typical trade winds. Note that there is still sediment in suspension in 2009 as a result of offshore waves.

WAVE ENERGY



NET SEDIMENT FLUX





CONCLUSIONS

• Broad fringing reef flat traps terrigenous sediment on the inner reef. In the trade wind season (April – November), daily winds act to drive strong currents and create waves that create a net sediment flux along t he reef flat.
•Tidal elevation and trade wind strength impact the amount of sediment resuspended on the reef flat.
•Between 2005 and 2009, there does not appear to be a large difference in concentrations of suspended sediment despite a concerted effort in upland sediment management.
• The net flux is strongly alongshore but also has an offshore component.