Controls on the Morphodynamics and Stratigraphic Architecture of Compound Dunes and Point Bars on the Open-Coast Macrotidal Flat in Gyeonggi Bay, West Coast of Korea*

Kyungsik Choi¹ and Joo Hee Jo²

Search and Discovery Article #51142 (2015)**
Posted September 14, 2015

Abstract

Simple and compound dunes are developed on the intertidal tributary channel and channel bank of the Yeochari macrotidal flat in Gyeonggi Bay, west coast of Korea. Dunes are asymmetrical with the majority of their steeper lee faces and master bedding surfaces dipping toward the ebb current direction. Dunes consist of cross-bedded medium to coarse sands with a coarsening-up textural trend, which overlie channel bank comprised of sand flat and mud flat facies and channel point bars composed of various channel facies including fluid muds and channel lags. Four-year long morphodynamic observations revealed that simple dunes on the tributary channel migrate seaward as fast as 1.5–2 m per day. In contrast compound dunes on the southern channel bank migrate either landward or seaward at much slower rates of 2–3 m per month. Despite greater current speeds on the channel bank, smaller tidal asymmetry leads compound dunes to migrate relatively slowly. In the case of intense wave activity, however, compound dunes seem to migrate at a noticeable rate. Compound dunes continued to shift their location over point bars toward northern channel bank as tributary channel migrates back and forth. Concurrent migration of compound dunes and channels produced a complicated stratigraphic architecture consisting of fining-upward point-bar succession overlain by coarsening-up compound-dune succession with master bedding surfaces dipping nearly opposite to those of point-bar succession. Tidal asymmetry, wave intensity, and migration of tributary channel are seen to exert an important control on the stratigraphic architecture of compound dunes and point bars in the intertidal environment.

References Cited

Choi, K., and J.H. Jo, 2015, Morphodynamics and Stratigraphic Architecture of Compound Dunes on the Open-Coast Macrotidal Flat in the Northern Gyeonggi Bay, West Coast of Korea: Marine Geology, v. 366, p. 34-48.

Dalrymple, R.W., 2010, Tidal Depositional Systems, *in* N.P. James and R.W. Dalrymple (eds.), Facies Models 4, Geological Association of Canada, St. John's, Newfoundland, p. 201-231.

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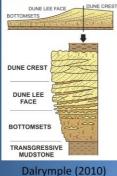


Controls on the morphodynamics and stratigaphic architecture of compound dunes and point bars on the open-coast macrotidal flat in Gyeonggi Bay, west coast of Korea

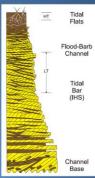
Kyungsik Choi and Joo Hee Jo

School of Earth and Environmental Sciences
Seoul National University, Korea

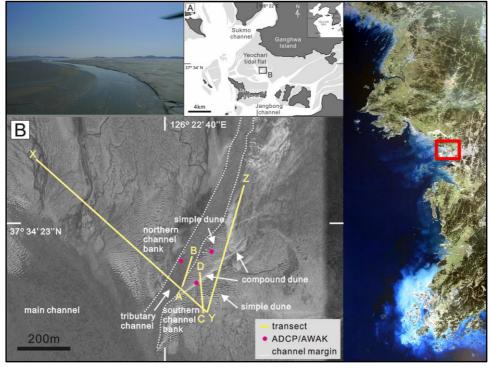
Dunes versus bars



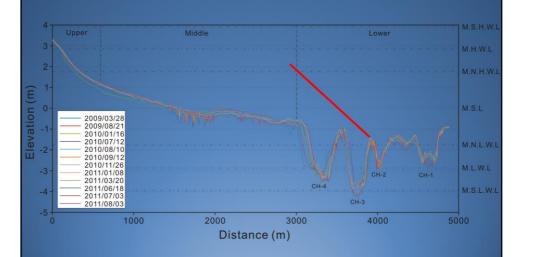
Lateral Forward MIGRATION SIZE Depth-Depthindependent (AMPLITUDE) dependent Coarsening up **STRATIGRAPHY** Fining up Parallel with Perpendicular **GEOMETRY** to flow flow Parallel with Perpendicular ARCHITECTURE (MASTER SURFACE) flow to flow

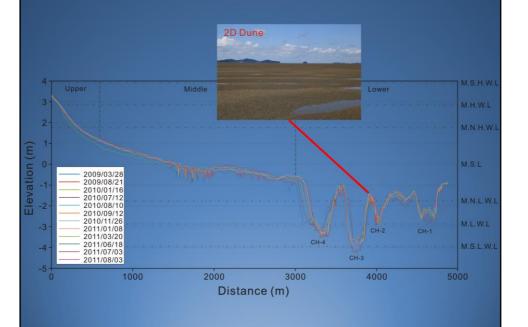


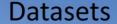
Dalrymple (2010)



Presenter's notes: Study area

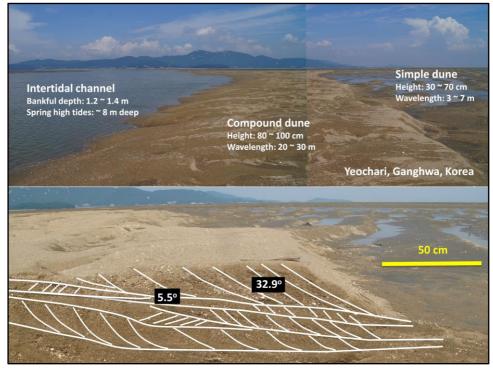




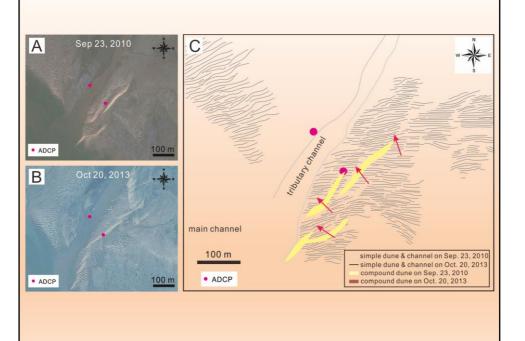


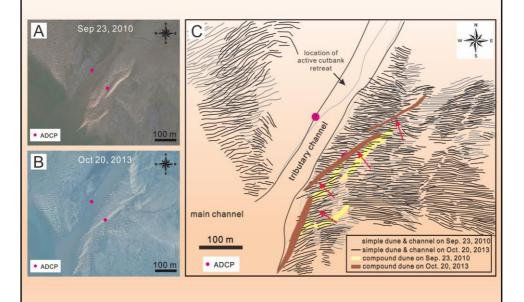
- Morphologic profilings along multiple transects conducted 16 times over four years (RTK GPS)
- Hydrodynamic measurements of tide, wave, SSCs at multiple locations for summer (2014.8) and winter (2015.3) (ADCP, AWAC, OBS)
- Facies analysis of 65 cores from channel and channel banks (cancorer)



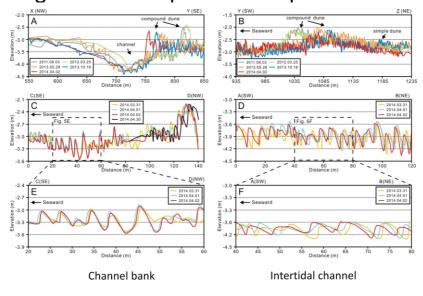


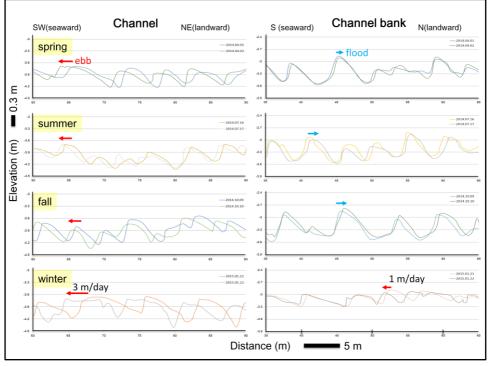
Presenter's notes: Occurrence, significance, challenges





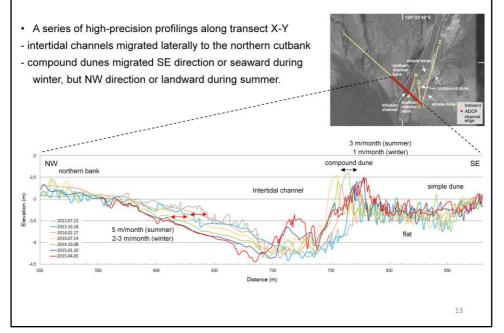
migration of simple and compound dunes





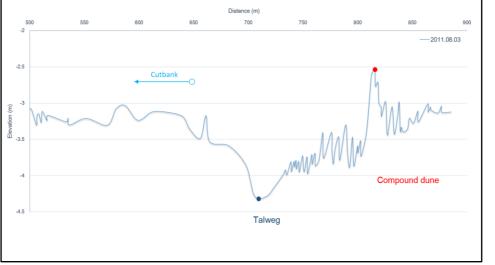
Presenter's notes: Simple dune migration: Migration rate of simple dune is greater in the channel than channel bank. Dunes tend to migrate ebbward direction in channel. Whereas dunes on the channel bank

Intertidal channel and compound dune migration

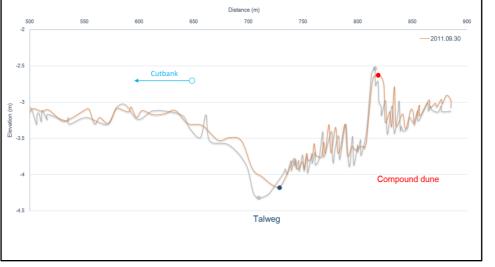


- Summer(July ~ October): asymmetrical cross section, flood-oriented: NW direction
 2014. 07 2014.10: summer rainy season ebb current dominant in channel –
- Winter(December ~ March): symmetrical or asymmetrical cross section, ebb-oriented : SE direction
- Rapid channel migration during summertime rainy season

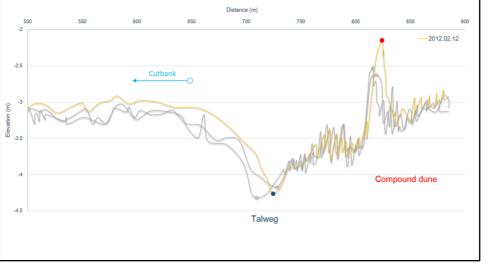
compound dune migrated towards SE direction



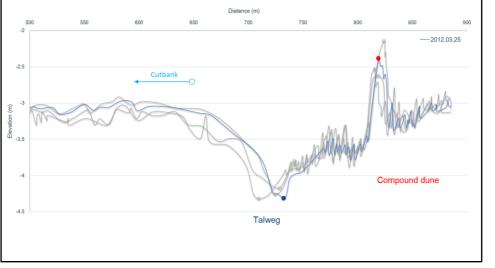
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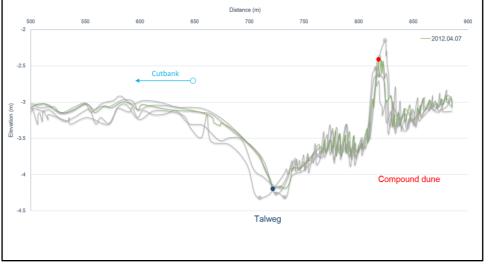
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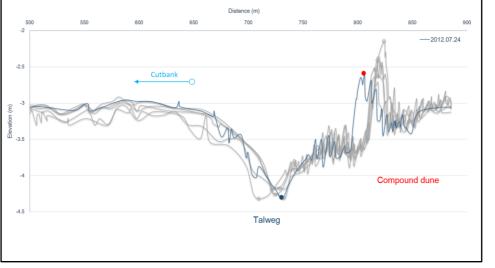
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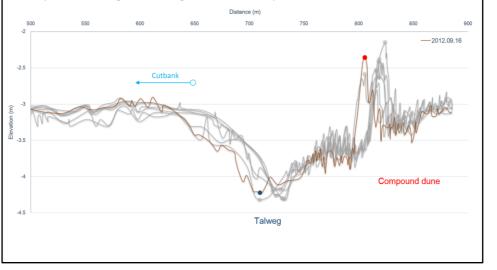
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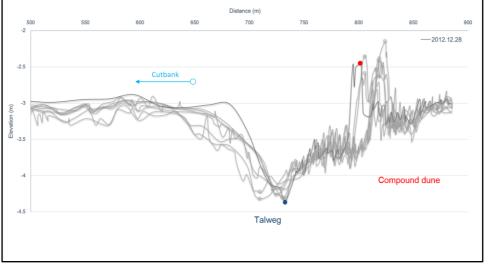
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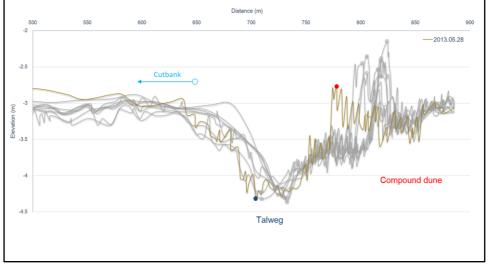
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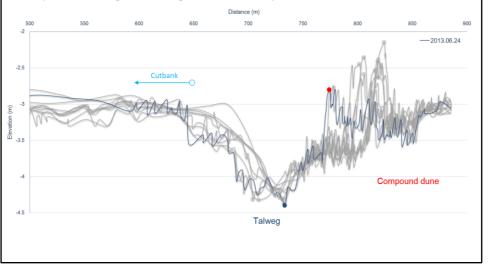
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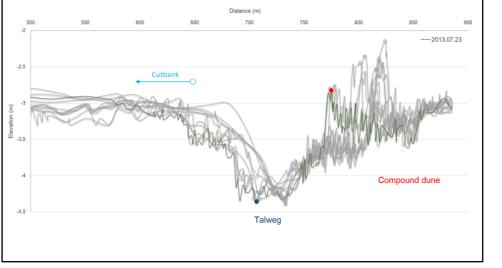
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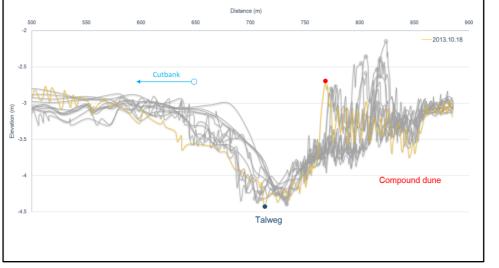
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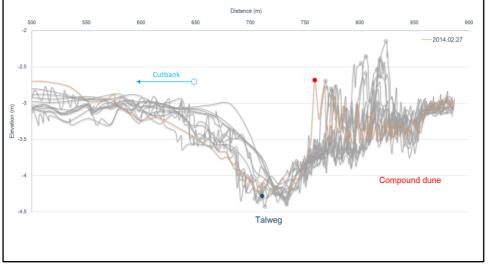
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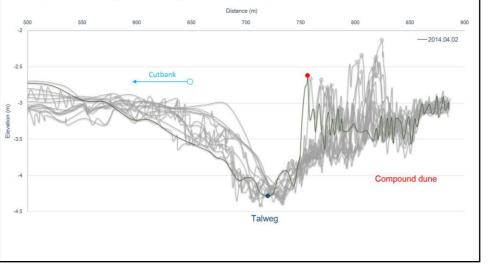
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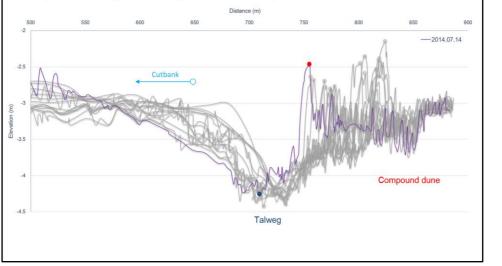
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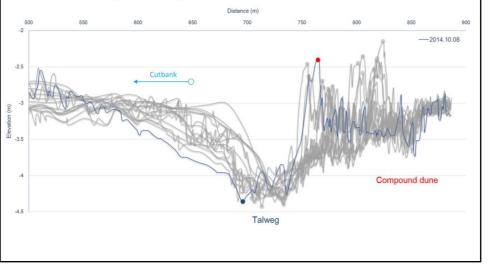
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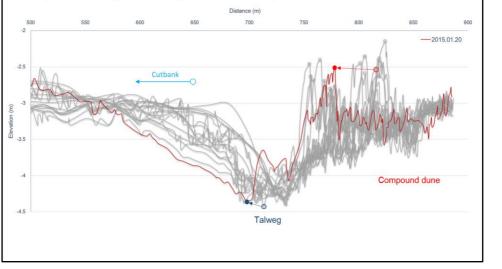
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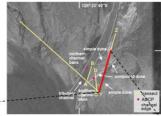


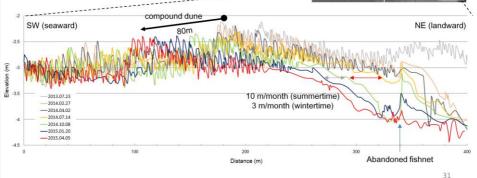
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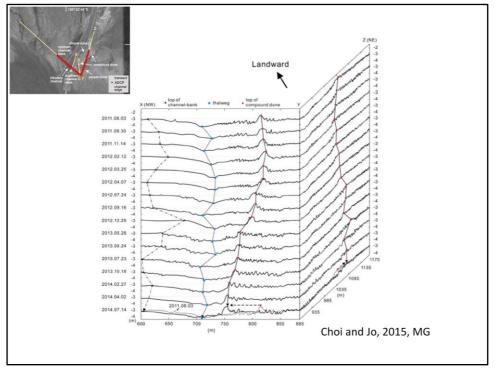


Intertidal channel and compound dune migration

- · A series of high-precision profilings Y-Z
- intertidal channels migrated toward SE direction
- compound dunes migrated either N or S direction
- channel migration during summer pushed compound dune further seaward

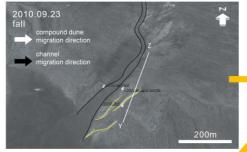




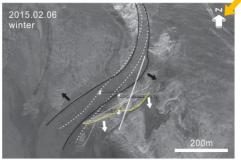


Presenter's notes: Time-series of profiles showing channelward and landward migration of compound dunes.

Compound dune migration during 5 years

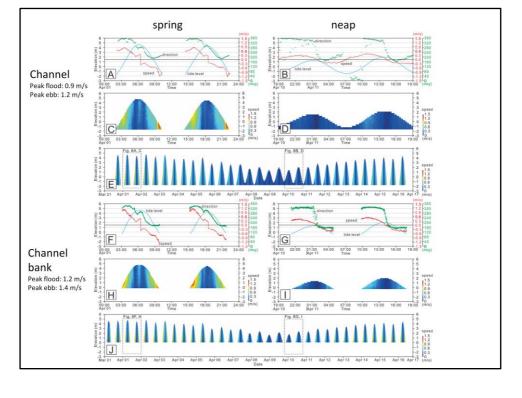


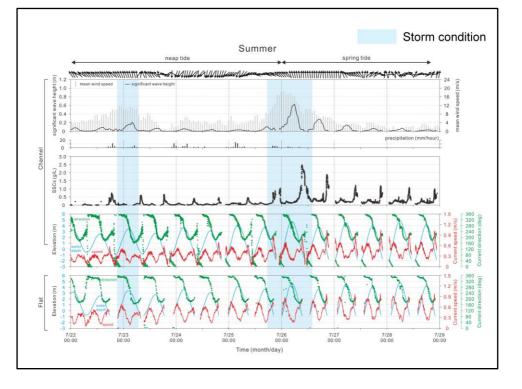


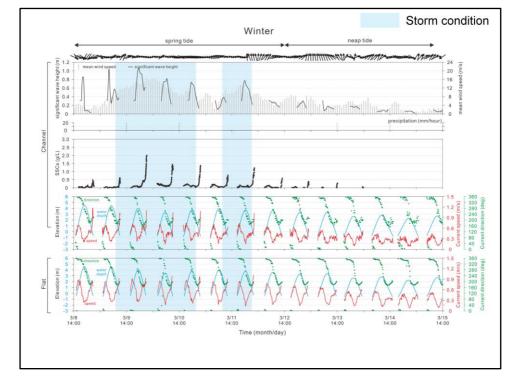


- · From 2010 to 2013,
- compound dune migrated NW direction (landward direction)
- · From 2013 to 2015,
- channel sinuosity increased
- compound dune near channel margin migrated S direction (seaward direction)

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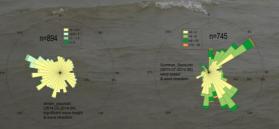


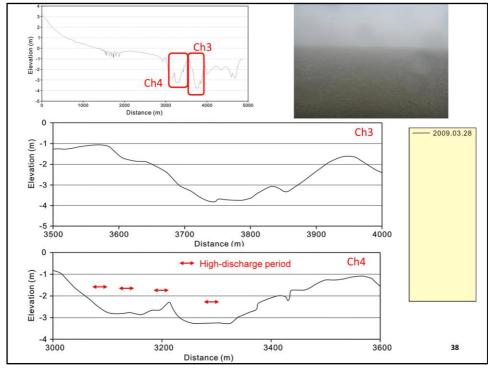




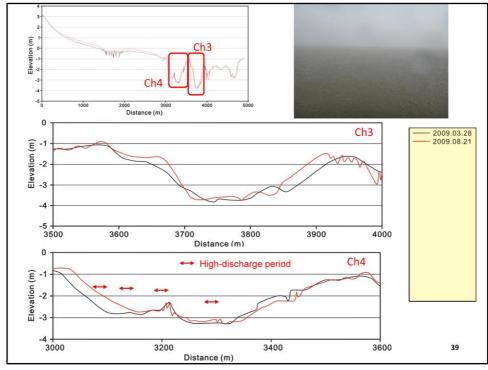
waves

- Significant wave height up to 1 m during peak spring high tide
- NW-W during winter to spring
- S-SE during summer to fall

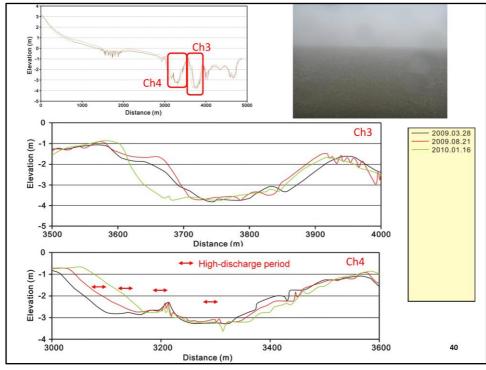




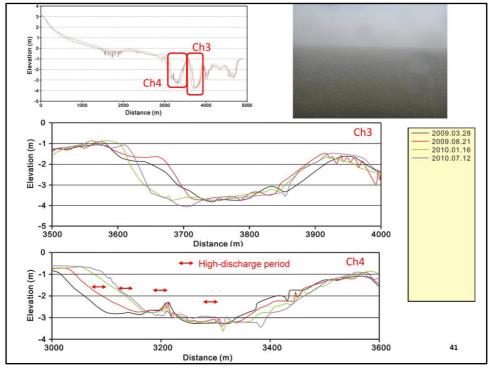
Presenter's notes: Similar morphodynamic change is observed at Yeochari tidal flat.



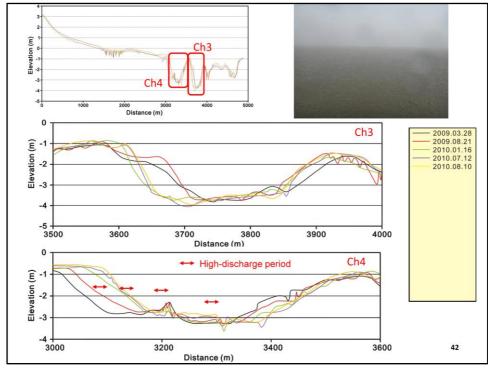
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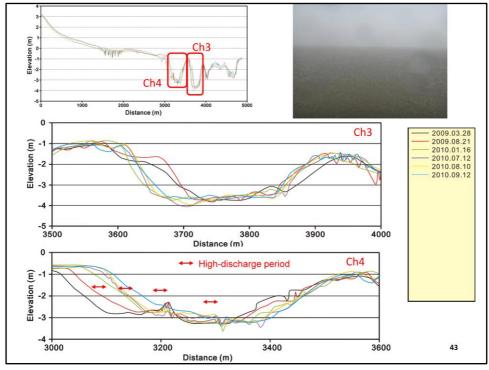
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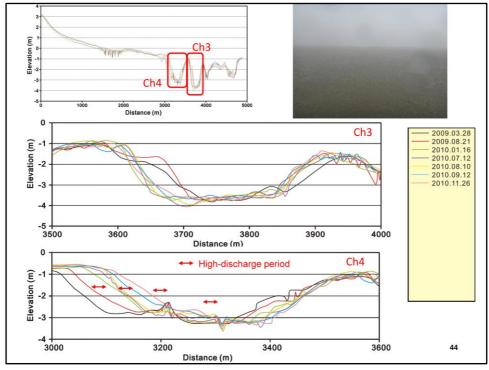
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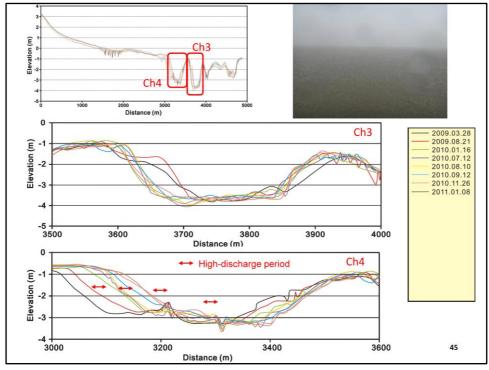
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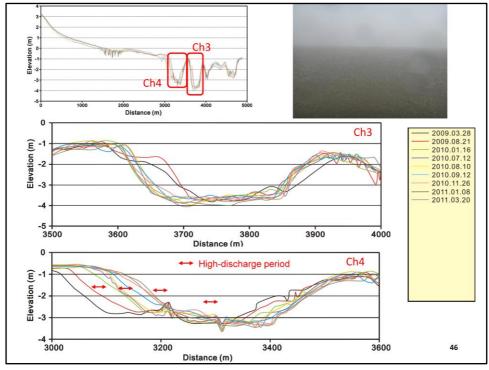
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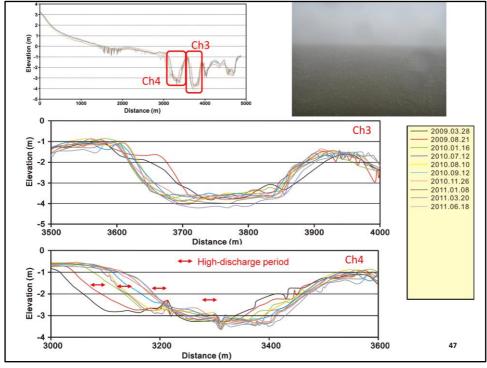
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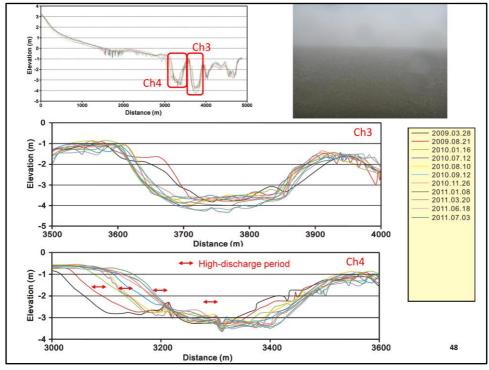
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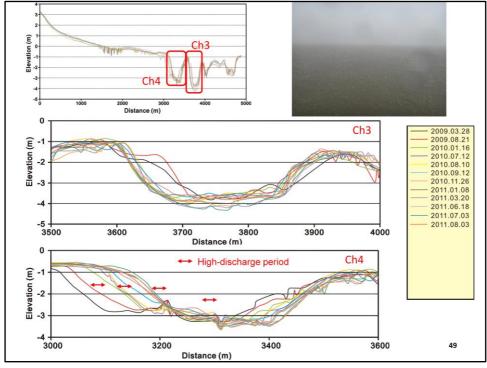
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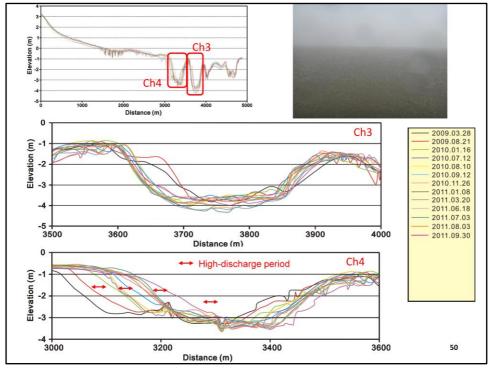
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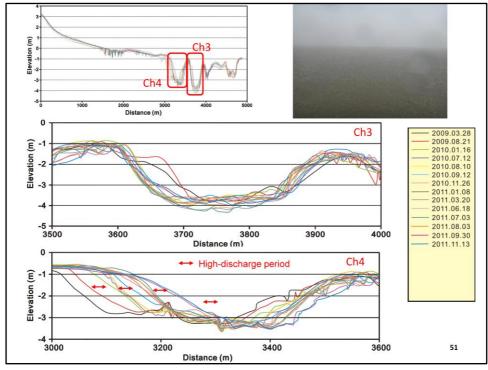
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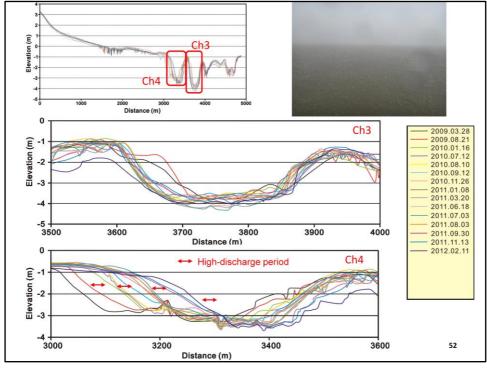
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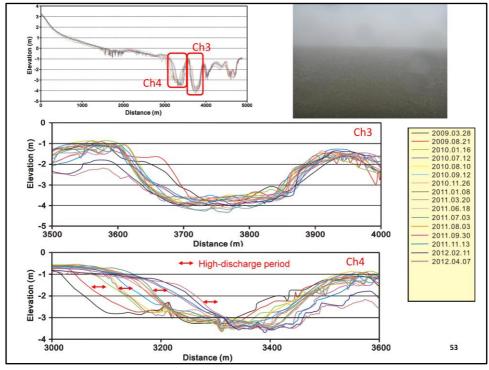
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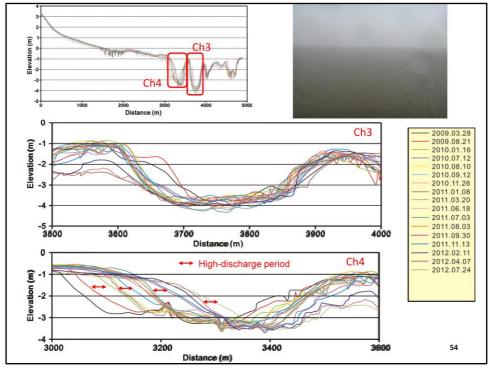
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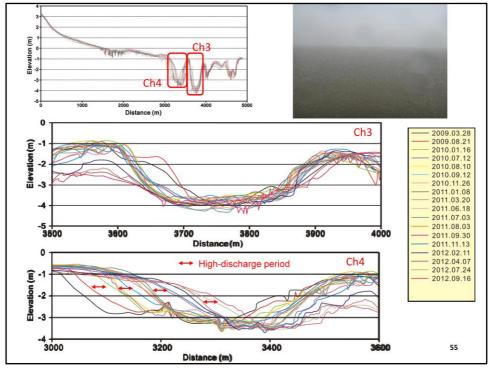
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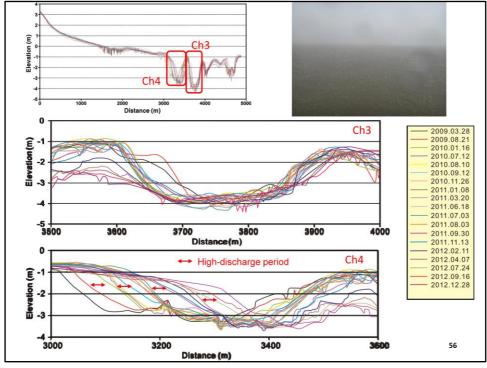
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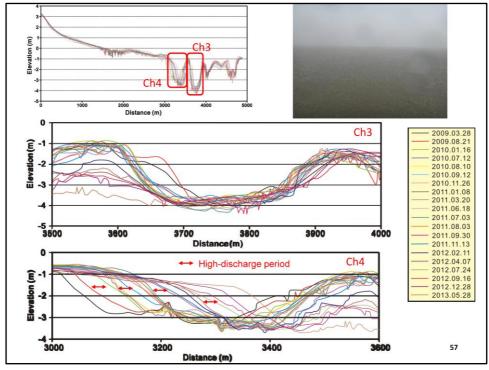
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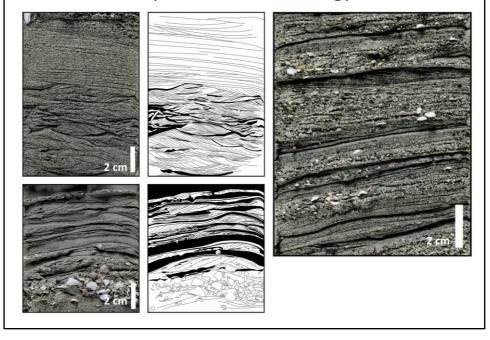


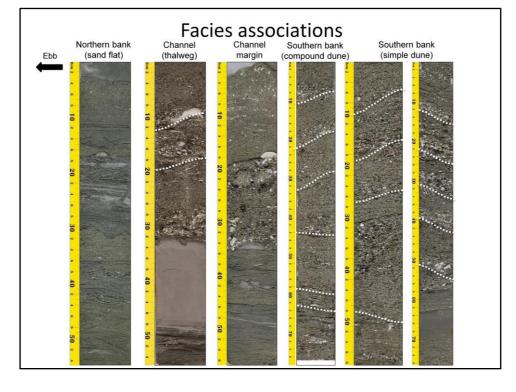
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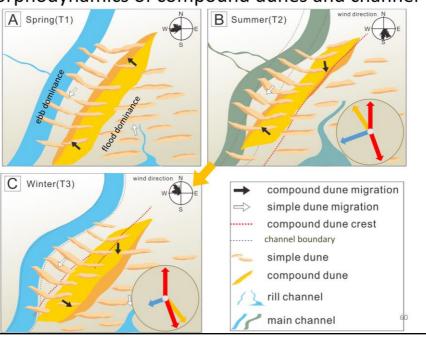
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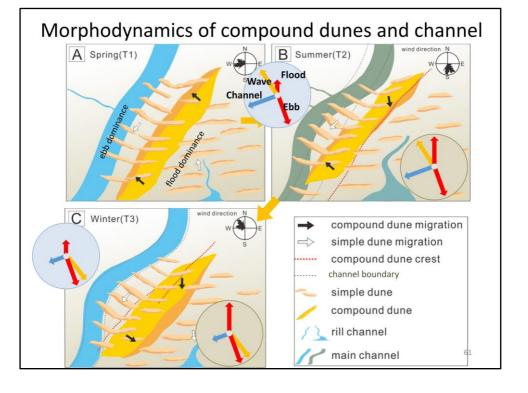
Sedimentary facies – mixed energy condition



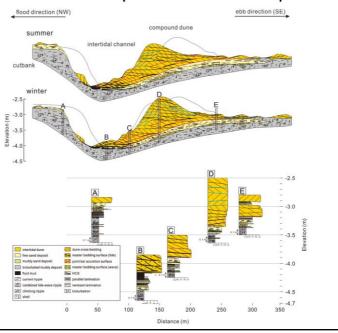


Morphodynamics of compound dunes and channel





Architecture of compound dunes and point bar



Conclusions

- Ebb-dominance with distinct tidal asymmetry in the channel leads to faster migration of dunes than channel bank despite weaker tidal current in the channel.
- NW to W waves during winter storms reinforce seaward migration of compound dunes, whereas S to SE waves during summer storms promote their landward migration.
- Concurrent migration of channel and compound dunes created a composite stratigraphic architecture in which master bedding surfaces of compound dunes dip in the opposite direction to the accretion surfaces of the pointbar succession.
 - Compound dunes on the lower intertidal zone of Yeochari tidal flat migrate in response to combined effect of tidal currents, waves and discharge fluctuation, which make architecture variable in time and space.