Peat archives: the key to unravel the influence of peat compaction on delta evolution

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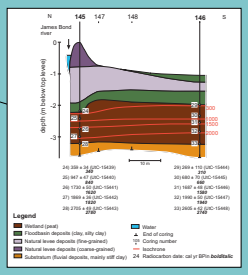
BACKGROUND

Natural compaction of peat layers, caused by loading, self-weight and/or groundwater table lowering, leads to high amounts of subsidence. Effects of this process on the evolution of deltaic systems have seldom been investigated. The ultimate aim of this study is to determine the effect of peat compaction on delta evolution. Study areas are the Cumberland Marshes (Canada), the Biebrza National Park (Poland) and the Rhine-Meuse delta (the Netherlands). We present a new method applied in the Cumberland Marshes to determine the amount and rate of peat compaction and asses which factors control peat compaction. Eventually, these results are used to assess effects of peat compaction on floodplain formation and avulsion, which is one of the most important processes controlling delta evolution.

METHODS

METHOD 1

Construct **cross sections** based on logged boreholes



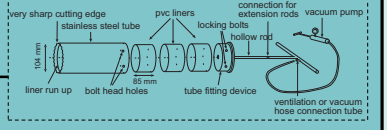
Dry bulk density (**DBD**) and Loss On Ignition (**LOI**) measurements of…

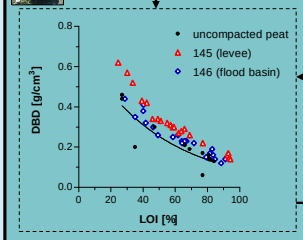
5x1x1 cm peat sampler

…uncompacted peat

...compacted peat cores

A new peat sampling device

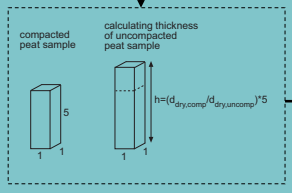


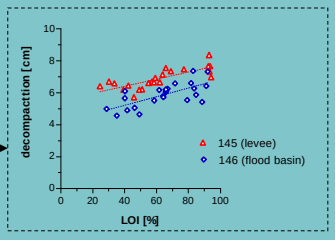


Set up **equation** to calculate the uncompacted DBD of compacted peat

$DBD_{uncomp} = a^{*}\exp(b^{*}LOI)$

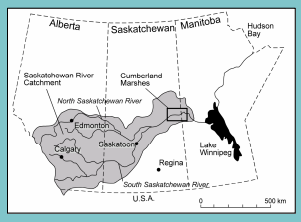
Calculate **decompacted thickness** of 5 cc peat samples





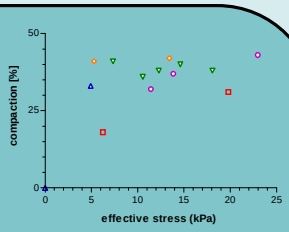
Compaction = volume reduction / decompacted thickness
Compaction rate = volume reduction / time since loading

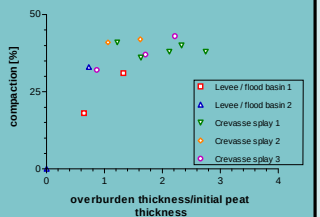
THE CUMBERLAND MARSHES



RESULTS

Overburden	Effective stress overburden (kPa)	Compaction [%]	Compaction rate [mm/yr]
Crevasse (levee)	12.29	38	1.19
Crevasse (sheet)	10.55	36	0.60
Crevasse (levee)	18.06	38	0.75
Crevasse (sheet)	7.34	41	0.52
Crevasse (levee)	14.60	40	1.04
Flood basin	4.94	32	2.19
No overburden	0	-4	0
Levee	19.78	31	1.42
Flood basin	6.26	18	0.83
Crevasse (levee)	22.97	43	2.03
Crevasse (sheet)	11.43	32	1.96
Crevasse (sheet)	13.87	37	1.38
Crevasse (sheet)	13.42	42	1.43
Crevasse (sheet)	5.92	41	1.73





Crevasse splay: same amount of compaction despite variation in overburden thickness.

max. compaction: **41 %**
max. compaction rate: **2.19 mm/yr**

CONCLUSIONS

1) High organic peat layers, containing fine fibers and overlain by a relatively thick clastic overburden (high stress) are most susceptible for compaction. Much compaction (up to 41%) due to loading occurs over centuries time.
2) Initially, crevasse splays form sheetlike deposits which uniformly compact underlying peat layer. Differential compaction occurs over longer time spans (centuries) when stable levees develop.
3) Peat compaction underneath natural levees and crevasse splay deposits creates additional accommodation space and hence increases local river sedimentation. We believe this process initially fixes river channels and prevents renewed avulsion. Furthermore, as long as peat is actively formed in flood basins, no gradient advantages are created. Crevassing is thought to be a more important processes leading to avulsion in low-gradient peatlands.

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