









**Flood Control
2015**

RSDYK

Dyke quality assessment by
remote sensing
and
geological information

Robert Hack



**Flood Control
2015**

Flood Control 2015 (FC2015)

Dutch Governmental research and
development program

Solutions for smart flood control



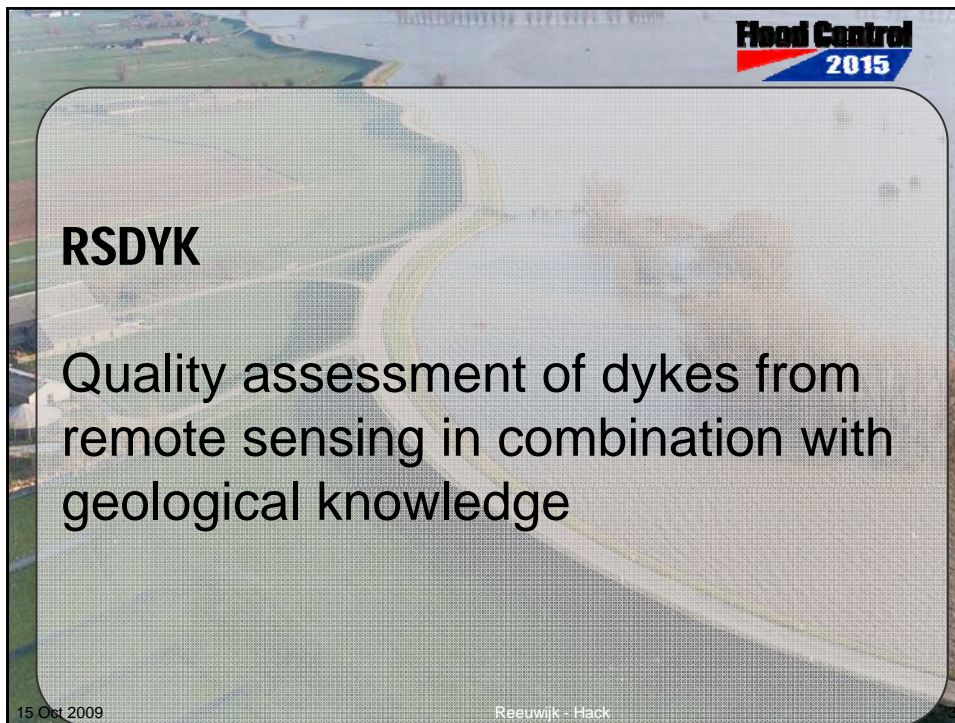








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RSDYK

Quality assessment of dykes from remote sensing in combination with geological knowledge

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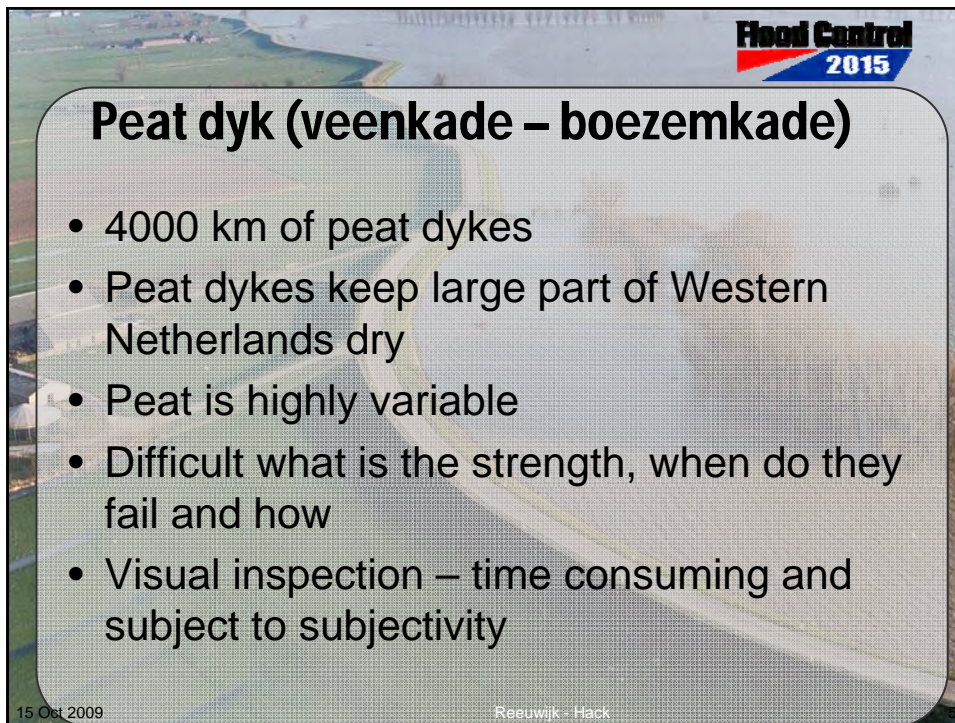
RSDYK

Remote sensing

Various applications:

- - Peatdyk
- - Quality of (vegetation) cover of dykes

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Peat dyk (veenkade – boezemkade)

- 4000 km of peat dykes
- Peat dykes keep large part of Western Netherlands dry
- Peat is highly variable
- Difficult what is the strength, when do they fail and how
- Visual inspection – time consuming and subject to subjectivity

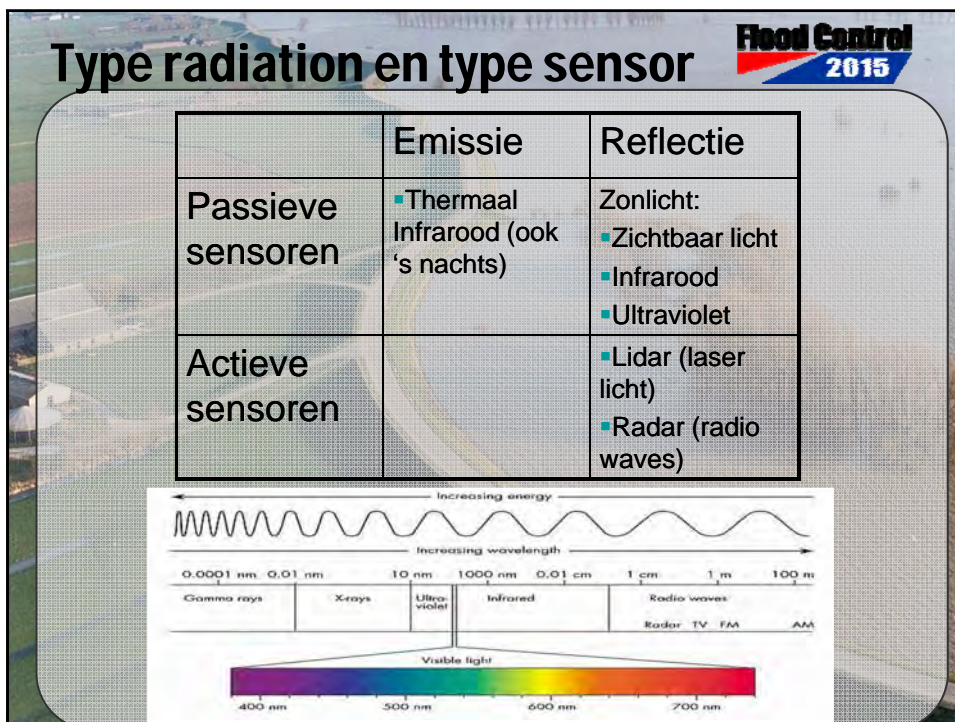
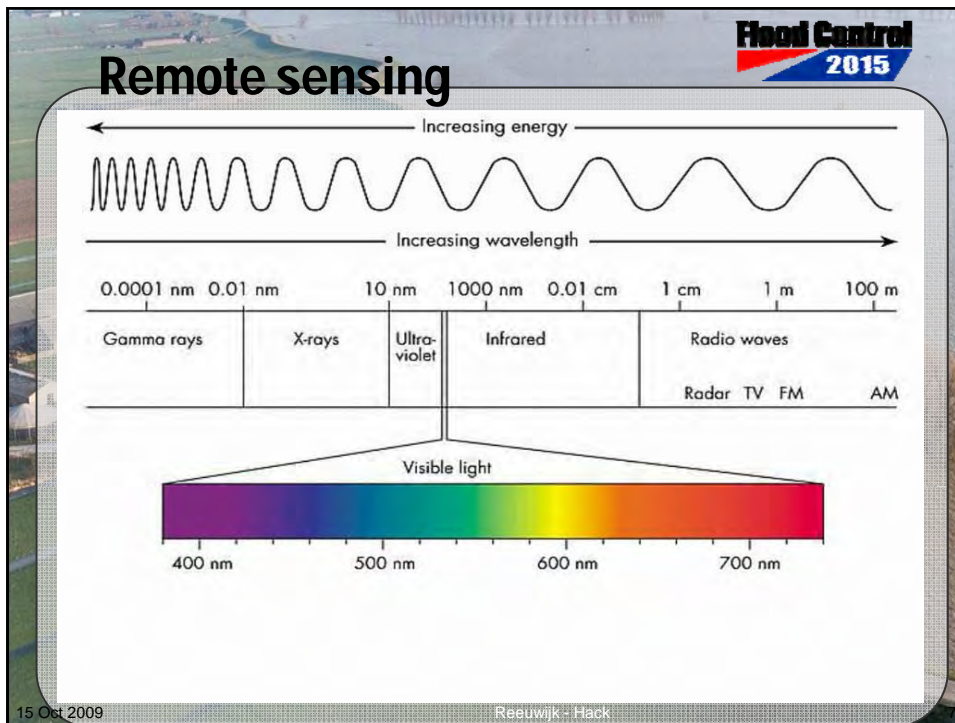
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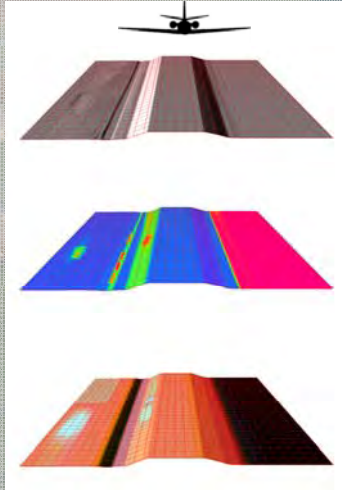
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Remote sensing

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Air-borne sensors

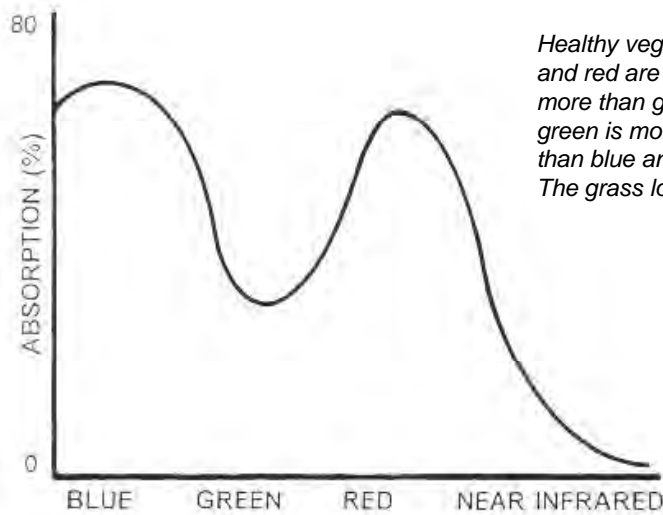


Laser scanning
(geometrie)

Thermaal Infrarood
(temperatuurverschillen,
vochtgehalte)

Multispectraal (vegetatie,
grondsoort, vochtverschillen)

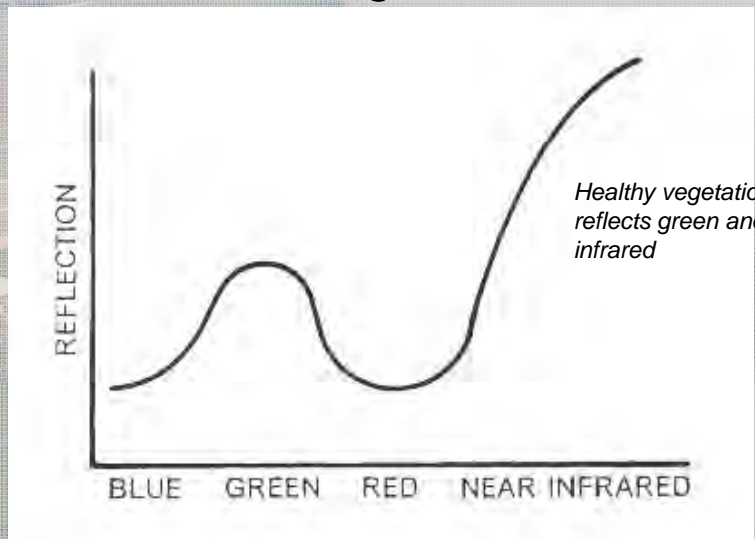
Reflectance vegetation



*Healthy vegetation: blue
and red are absorbed
more than green; or
green is more reflected
than blue and red:
The grass looks green*

(after: Introduction to Remote Sensing, Campbell 1996)

Reflectance vegetation



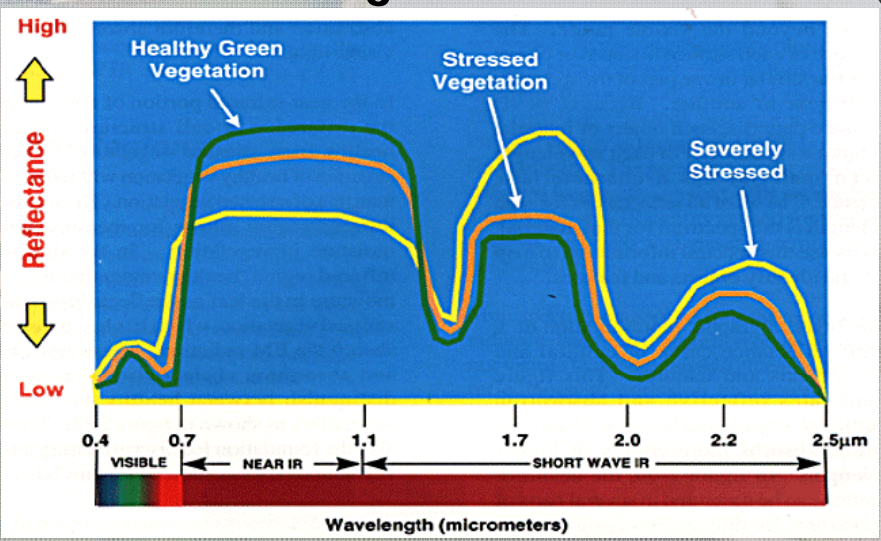
Healthy vegetation: reflects green and near infrared

(after: Introduction to Remote Sensing, Campbell 1996)

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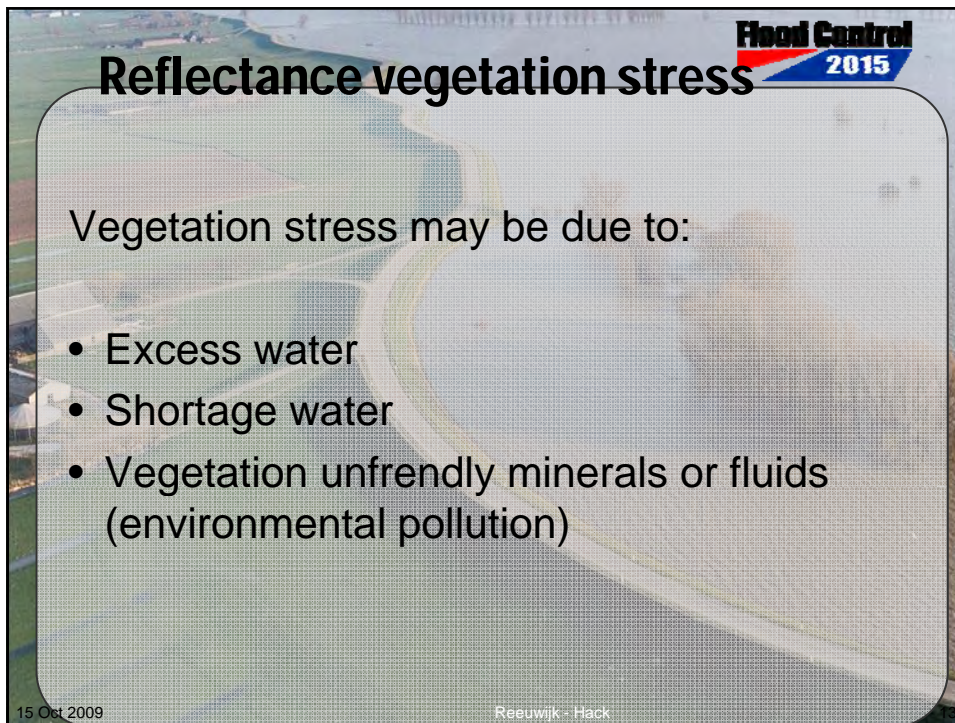
Reflectance vegetation stress



after: <http://www.csc.noaa.gov/products/sccoasts/html/rsdetail.htm>

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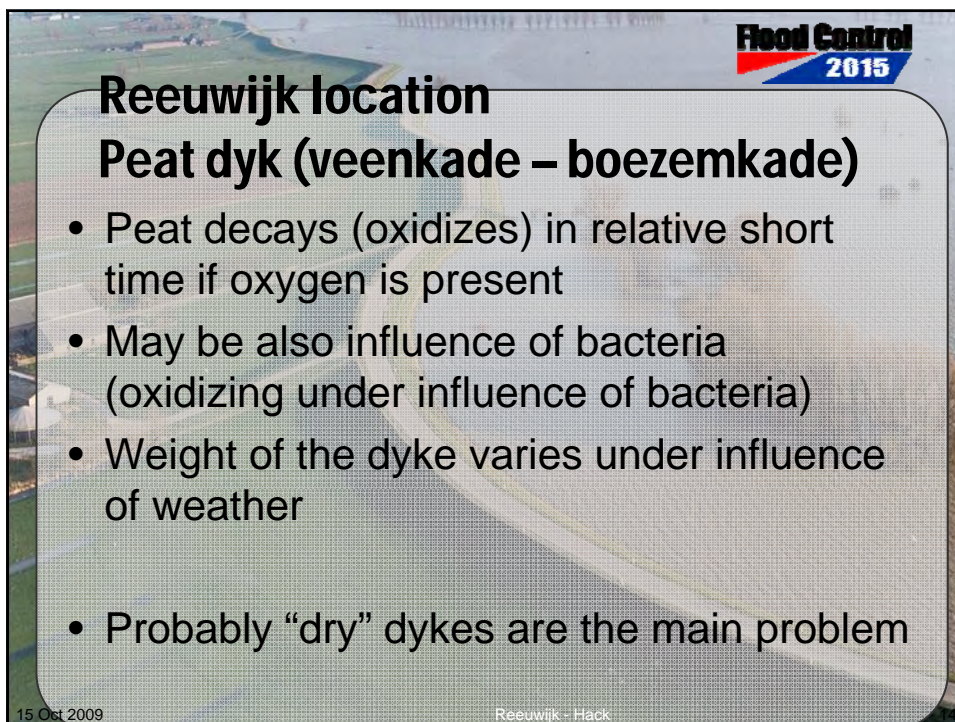
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Reflectance vegetation stress

Vegetation stress may be due to:

- Excess water
- Shortage water
- Vegetation unfriendly minerals or fluids (environmental pollution)

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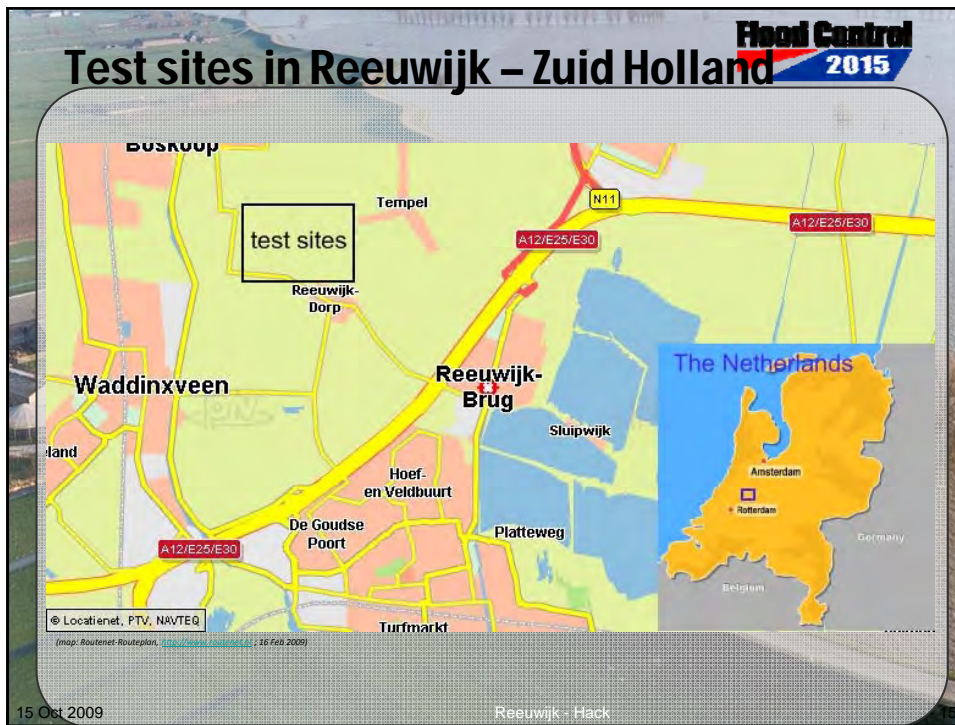
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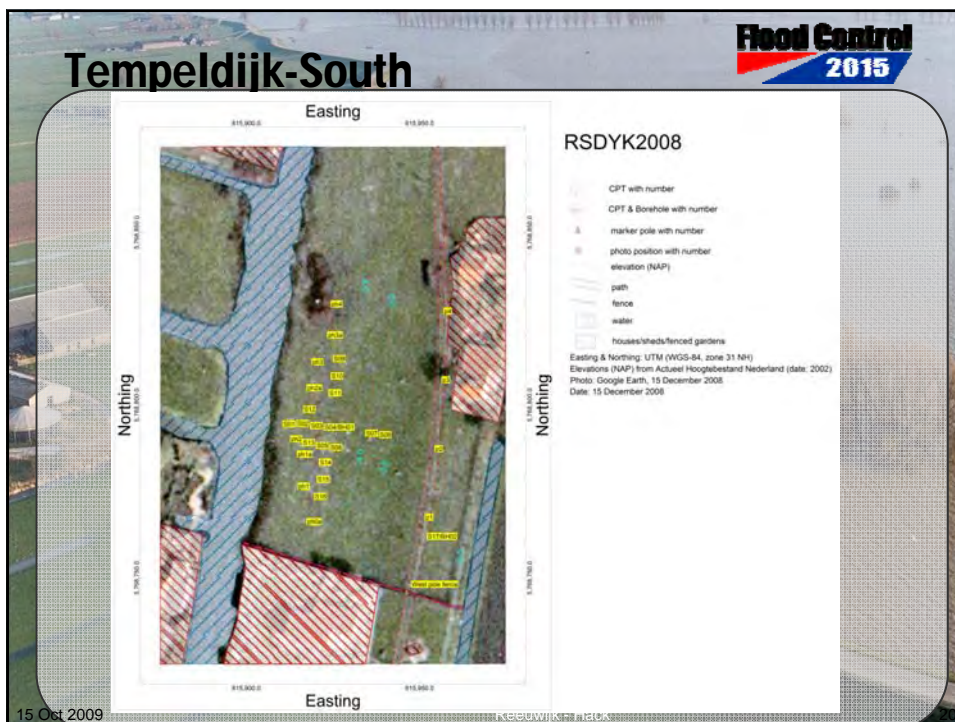
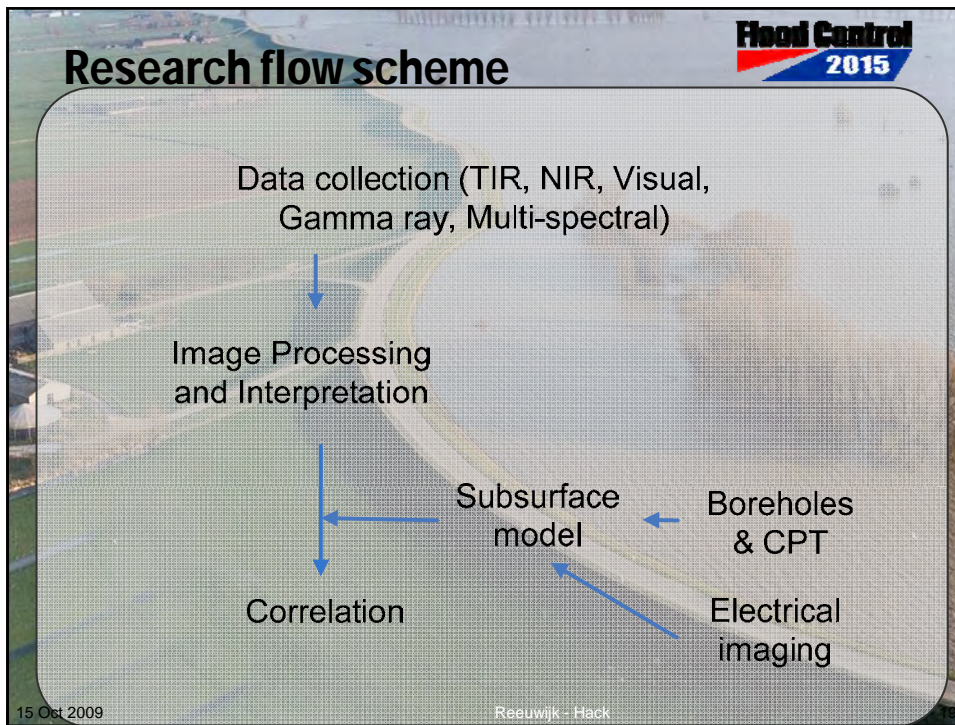
Reeuwijk location

Peat dyk (veenkade – boezemkade)

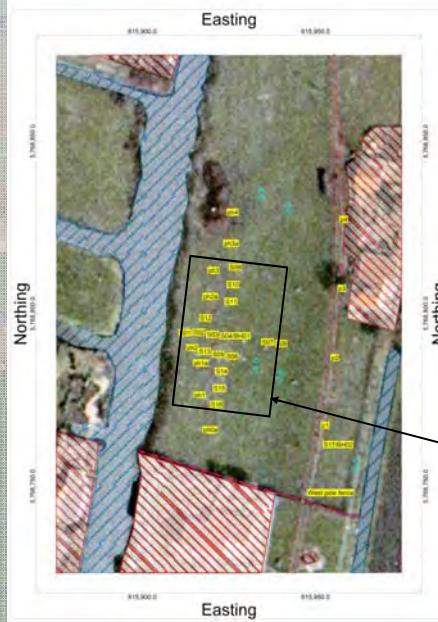
- Peat decays (oxidizes) in relative short time if oxygen is present
- May be also influence of bacteria (oxidizing under influence of bacteria)
- Weight of the dyke varies under influence of weather
- Probably “dry” dykes are the main problem

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Tempeldijk-South



RSDYK2008

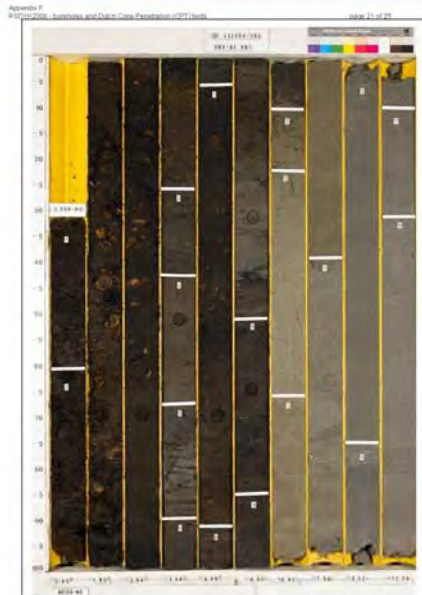
- CPT with number
- CPT & Borehole with number
- marker pole with number
- photo position with number
- elevation (NAP)
- path
- fence
- water
- houses/sheds/fenced gardens

Easting & Northing: UTM (WGS-84, zone 31 NR)
 Elevations (NAP) from Actueel Hoogtebestand Nederland (date: 2002)
 Photo: Google Earth, 15 December 2008
 Date: 15 December 2008

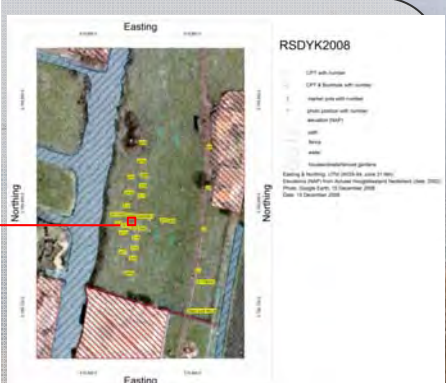
16 CPTs & 1 borehole in area of about 30 x 45 m²

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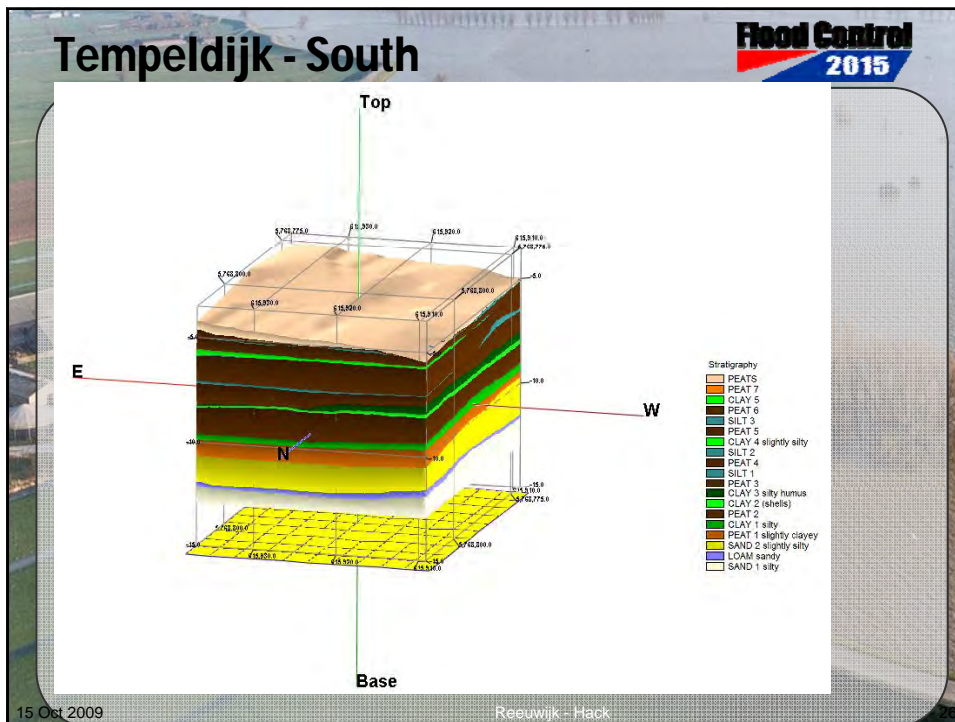
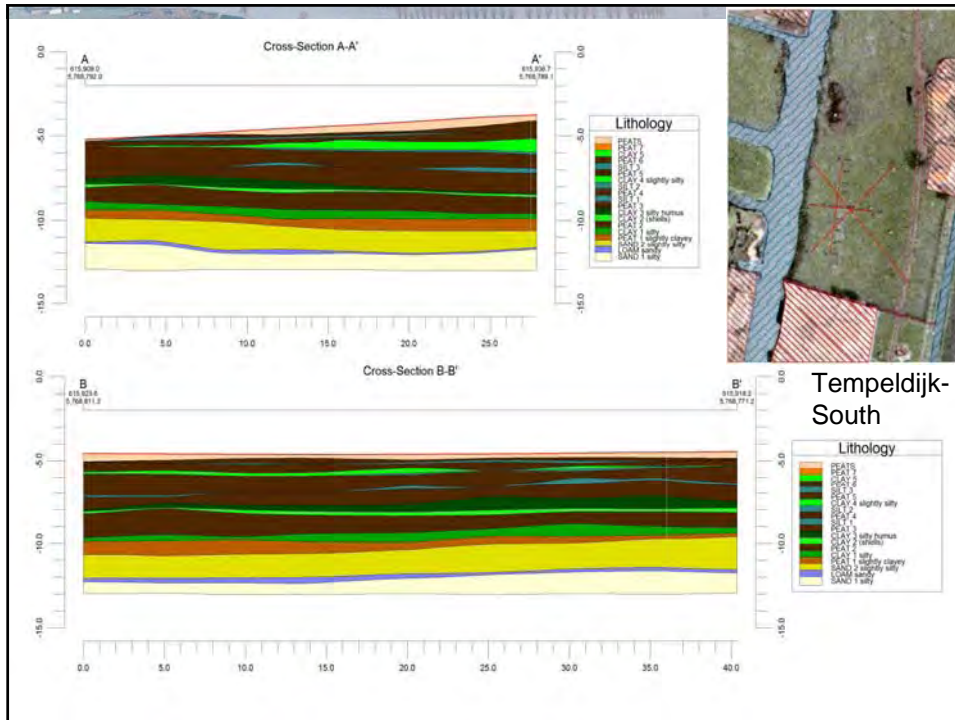
Deltares Grondsonderzoek Rееevijk FC 2015 Rееevijk FOTO BORING B01 bij S04 Type: Begemanboring 66 mm		Document: 2008-12-18 Datum: 2008-12-18 Locatie: Rееevijk Project: CO-432500/380 Blad: B.L. BFB1 Afdeling: A4	
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RSDYK2008

- CPT with number
- CPT & Borehole with number
- marker pole with number
- photo position with number
- elevation (NAP)
- path
- fence
- water
- houses/sheds/fenced gardens

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Geophysics 3D resistivity imaging

3D resistivity imaging for confirmation of sub-surface model

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Tempeldijk

Canal

Poles (20m apart)

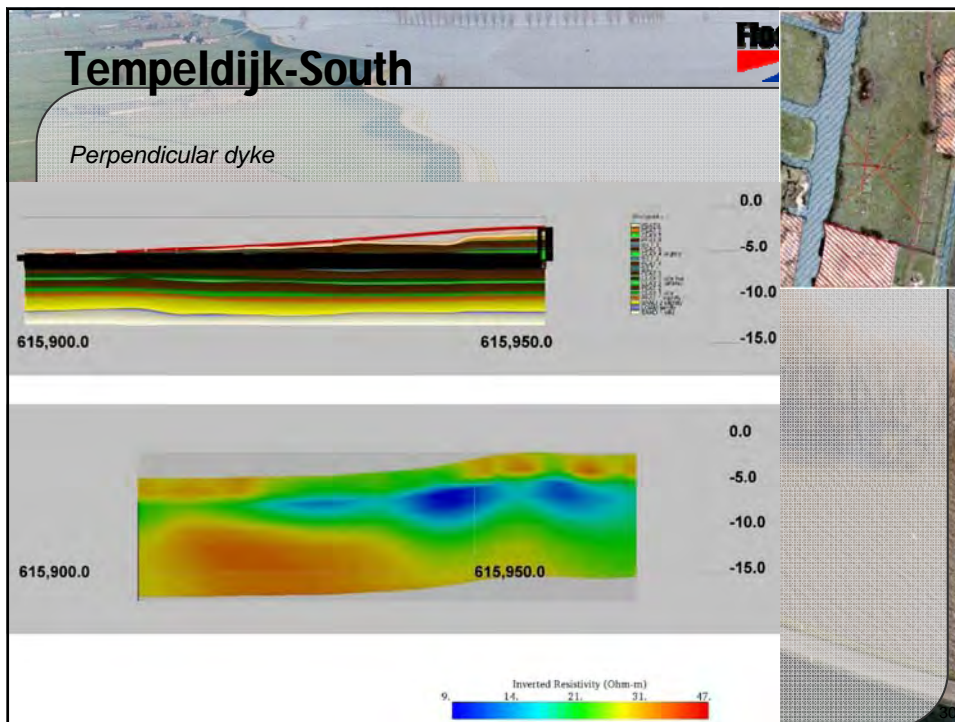
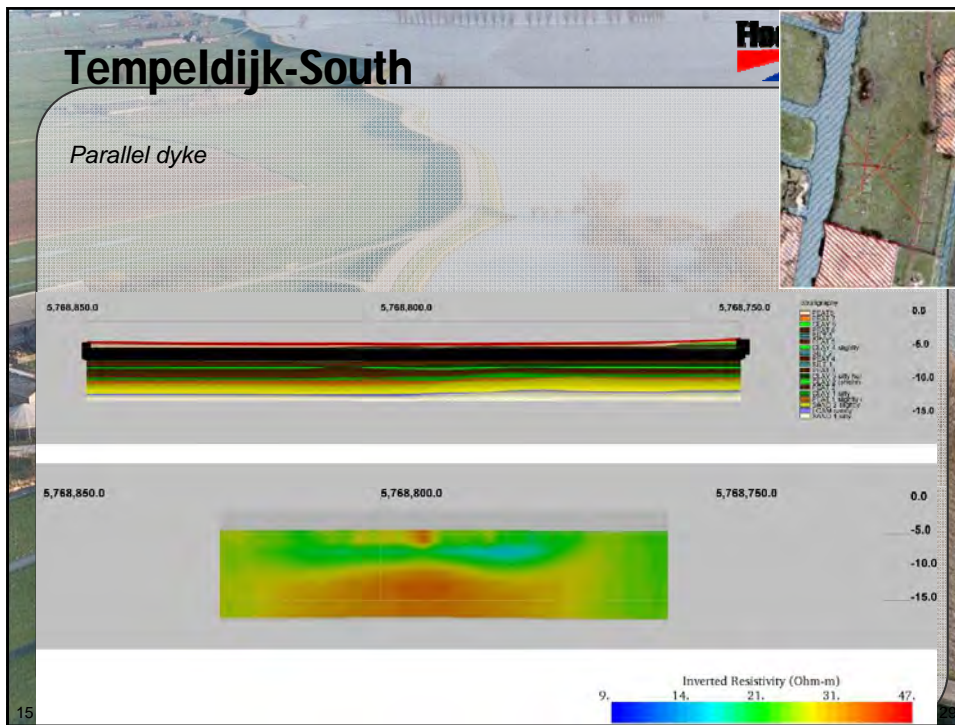
Main body of the dyke

STING R1/IP

Electrodes attached by multi cables

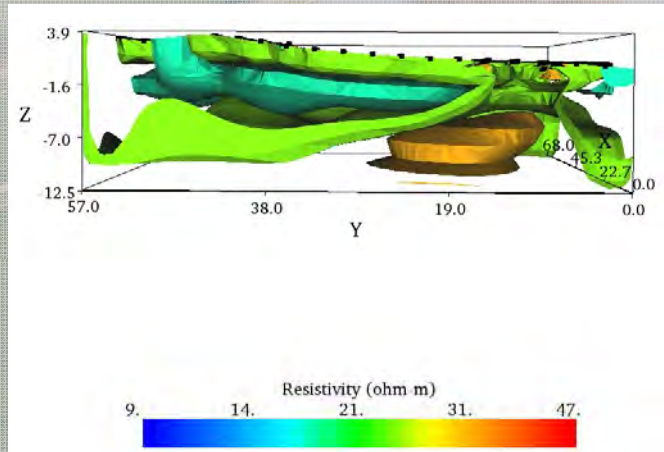
A 2-D electrical imaging survey on the Tempeldijk-North

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Tempeldijk-South

3D Resistivity contour plot




Remote sensing Tempeldijk-south

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Tempeldijk-south visual light

Visual images of Tempeldijk-South showing the difference in the apparent surface roughness in (a) August 15, 2007, (b) October 31, 2007 and (c) December 13, 2007



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Multi-spectral-near infrared



ADC multispectral NIR

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Multi-spectral near-infrared

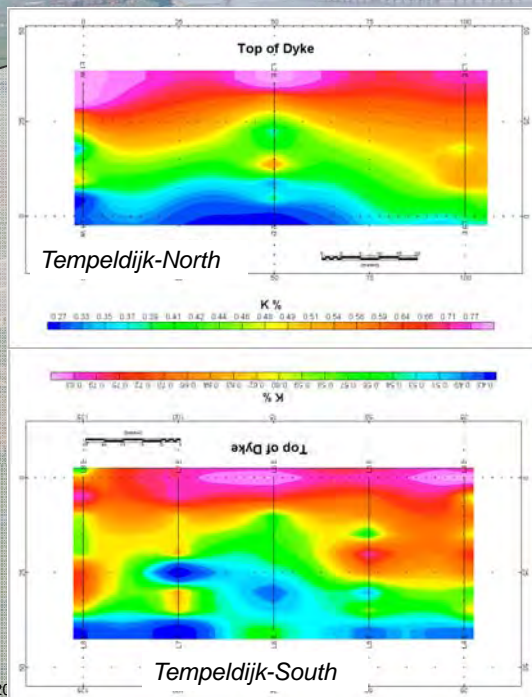


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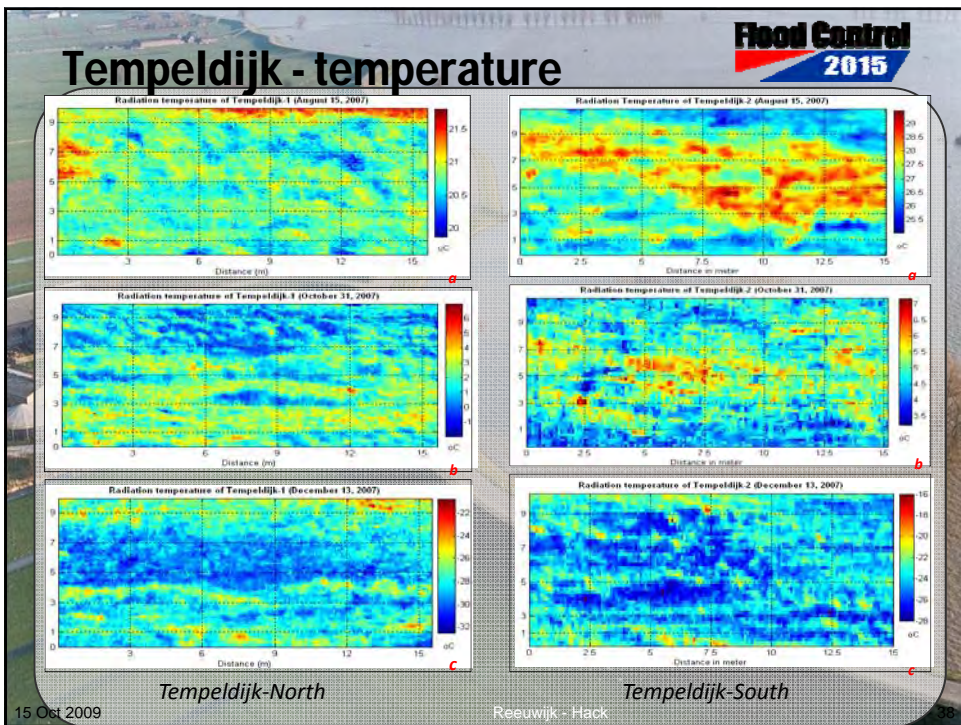
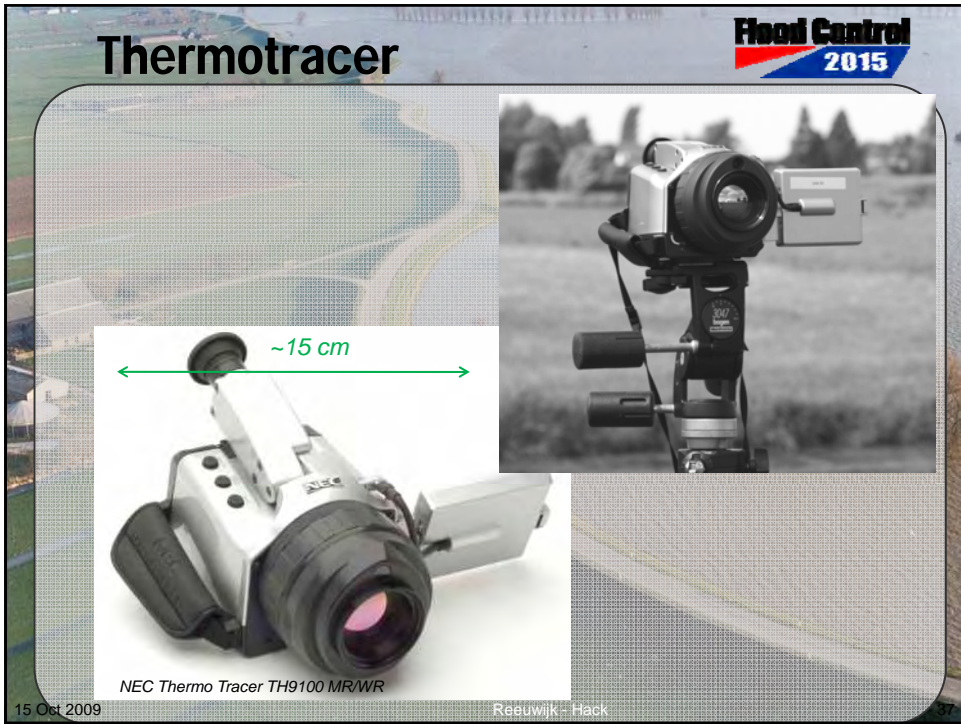
36

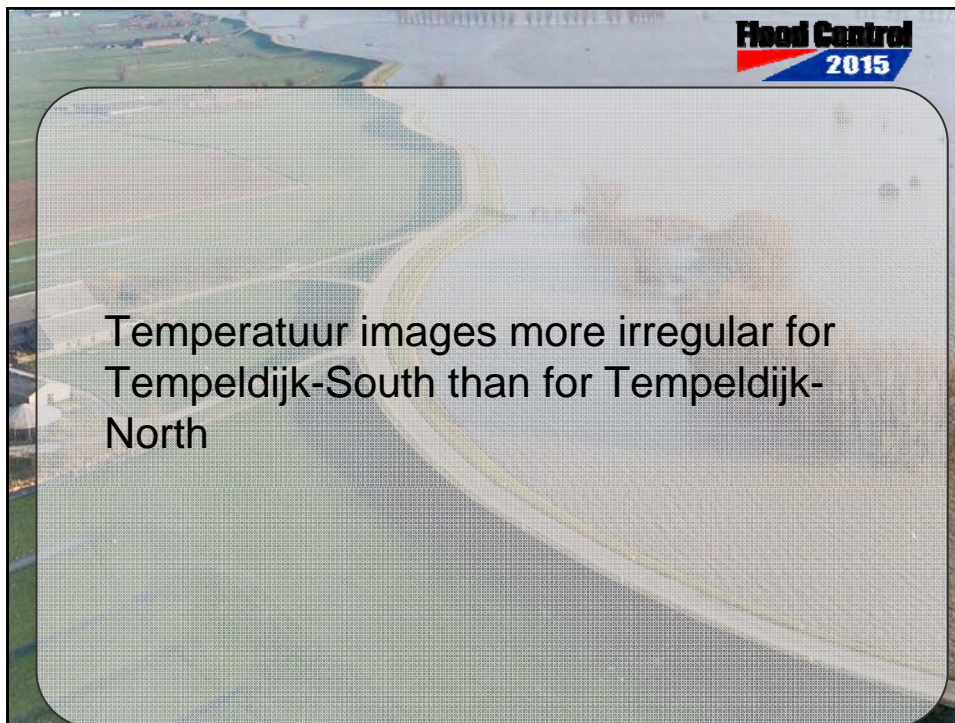
Gamma ray



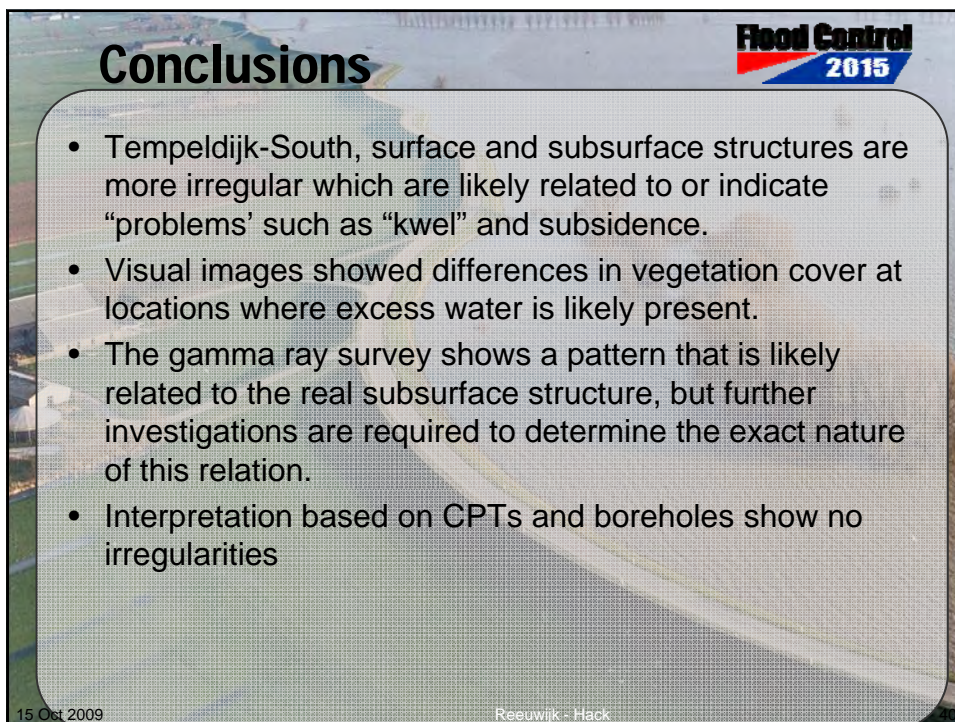
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Temperatuur images more irregular for Tempeldijk-South than for Tempeldijk-North



Conclusions

- Tempeldijk-South, surface and subsurface structures are more irregular which are likely related to or indicate “problems” such as “kwel” and subsidence.
- Visual images showed differences in vegetation cover at locations where excess water is likely present.
- The gamma ray survey shows a pattern that is likely related to the real subsurface structure, but further investigations are required to determine the exact nature of this relation.
- Interpretation based on CPTs and boreholes show no irregularities

RSDYK2009-2012

- 2 AIOs/PhD students
- Relations between subsurface and remote sensing on dykes
- Relations between groundwater and remote sensing on dykes
- Relations quality assessment dykes and remote sensing