Using Model Predictive Control to utilize green cloudburst solutions for smaller rain events

Morten Borup
morb@env.dtu.dk

Most slides by:
Nadia Lund
nalu@env.dtu.dk
Management of extreme rain events

Copenhagen

Before 2010: No cloudbursts

From 2010 to 2016: 5 major cloudburst in 7 years, with damages of billions of Euros
Climate adaption plan for extreme rain events

- 300 cloudburst projects
- Implementation over 30 years
- Total cost: 11 bill. DKK
The design of a cloudburst road

Dry weather

Normal rain

Extreme rain
Example of retention space
Management of minor to medium rain events

Combined sewer overflow (CSO)
Underlying idea

Can you combine 1) management of smaller rain events with 2) climate adaptation for extreme rain through above-ground control – and hereby minimize the total CSO volume?

Current situation: underground control

- Rain falling on hard surfaces becomes runoff
- The runoff enters the sewer system
- This may lead to CSO

Diagram: Rainfall on hard surfaces, runoff into the sewer system, leading to CSO.
Underlying idea

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Control of water on terrain

- Rain falling on hard surfaces becomes runoff
- The sewer system capacity will not be exceeded
- The sewer system capacity will be exceeded
- The runoff should not enter the sewer system and instead make use of the cloudburst projects
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Model predictive control in general

Input

Finite time horizon

Recursive optimization

Optimization

Implemented control

Control

Now
Model predictive control – in this study

Internal MPC model

Controlling 7% of the upstream area to a CSO
Results and discussion

18 events in 2016 resulting in CSO

Maximum reduction = 72%
Average reduction = 11%
Total volume reduced = 3829 m³
Results and discussion

14 events in 2016 not resulting in CSO
Conclusions – is it worth the effort?

Can you combine 1) management of smaller rain events with 2) climate adaptation for extreme rain through above-ground control – and hereby minimize the total CSO volume?

YES

• Above-ground MPC may send water on terrain even though there would not be a CSO.

• Using 2 out of the 300 cloudburst projects in above-ground model predictive control reduced the amount of CSO with on average 11%, but at times up to 72%.

• Imagine what we could do if we expanded the concept to cover all 300 cloudburst projects?