



TECHNIEK
EN MANAGEMENT



Introductie RTC-tools

Klaas-Jan van Heeringen

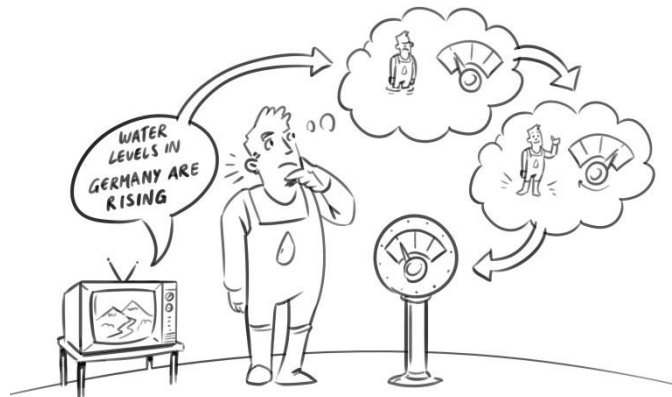


Real-time Control

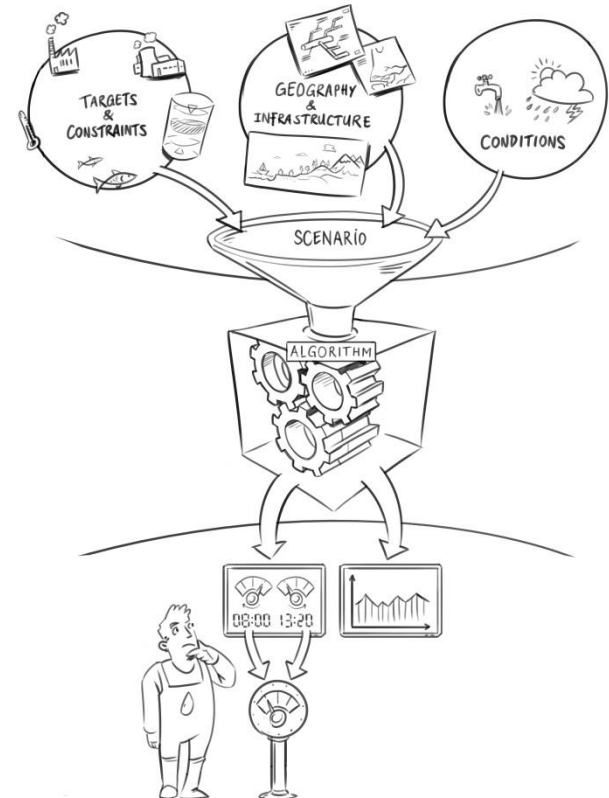
FEEDBACK CONTROL



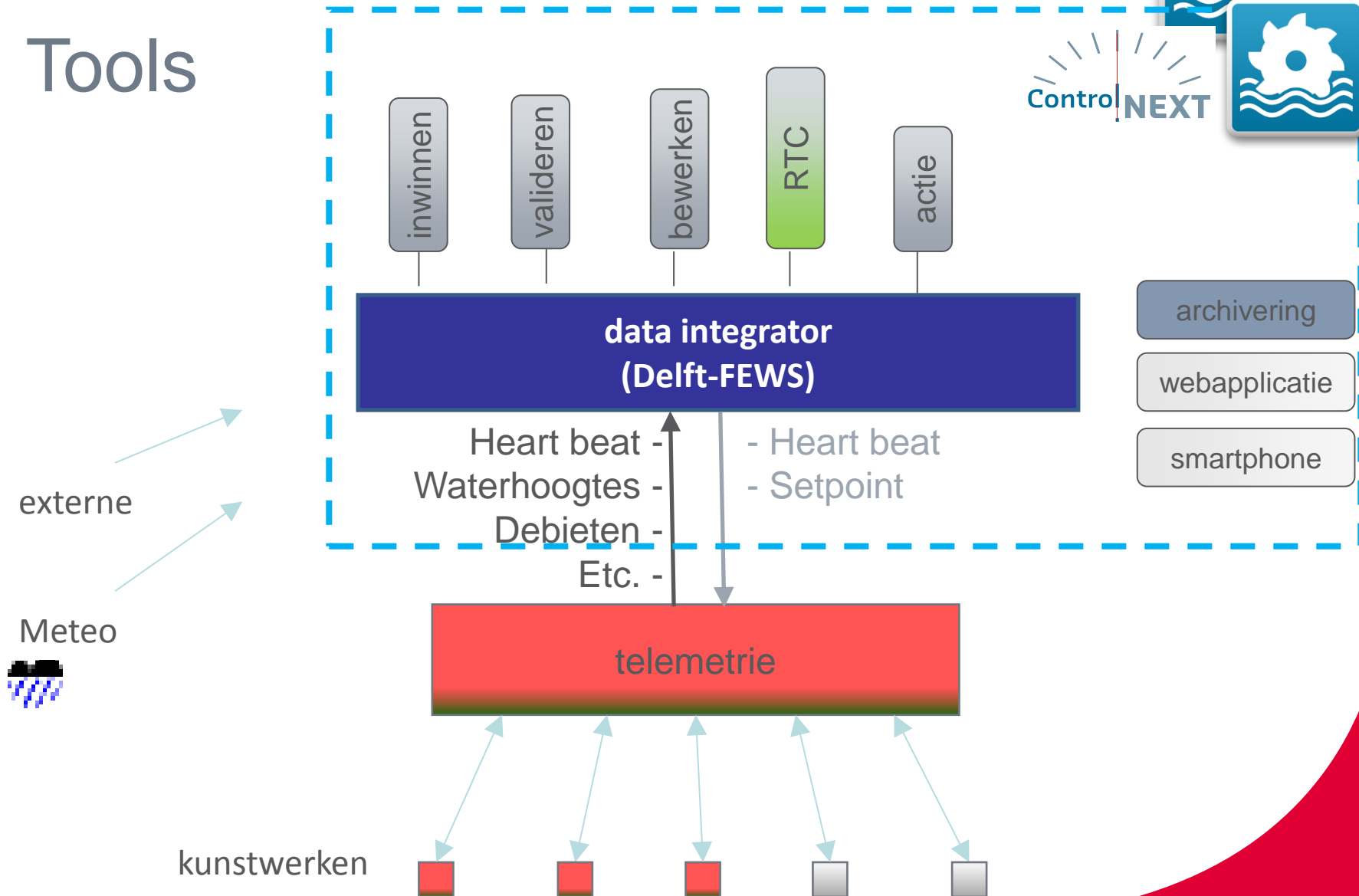
FEEDFORWARD CONTROL



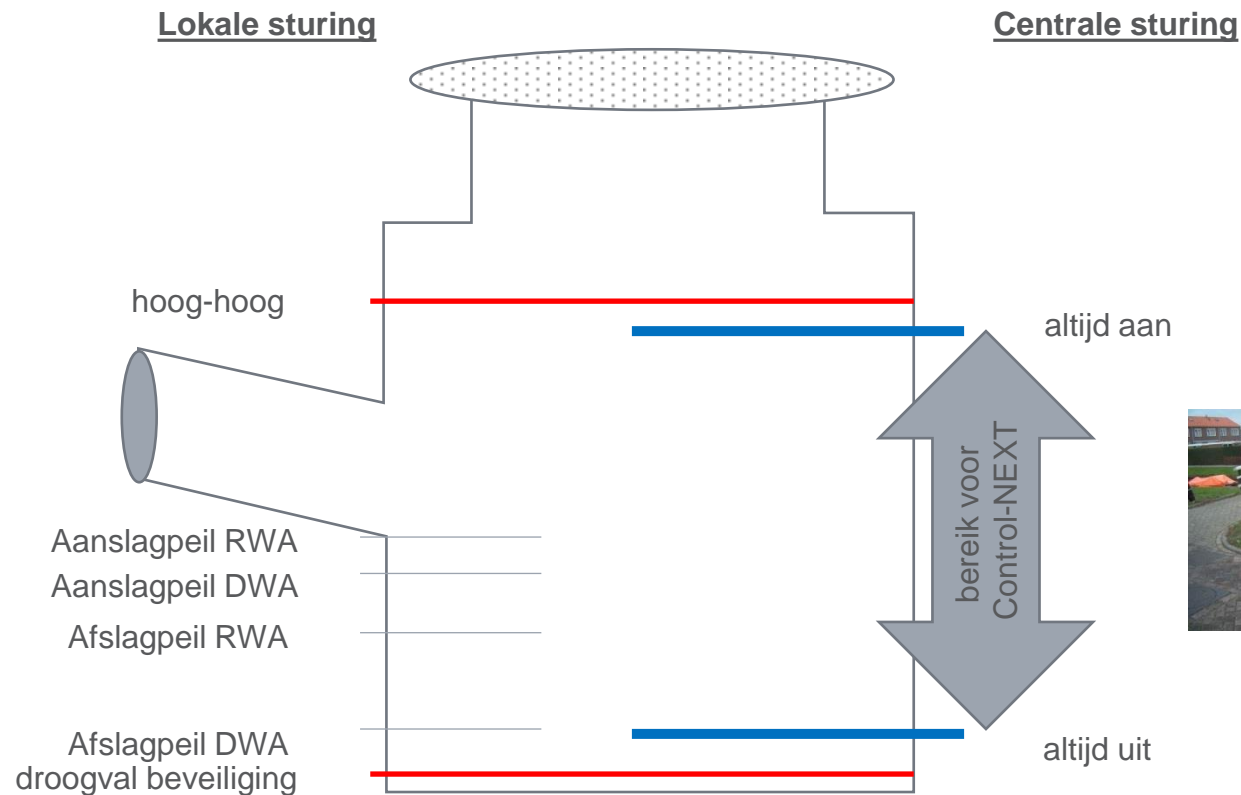
MODEL PREDICTIVE CONTROL



Tools



Backupstrategie





RTC programming

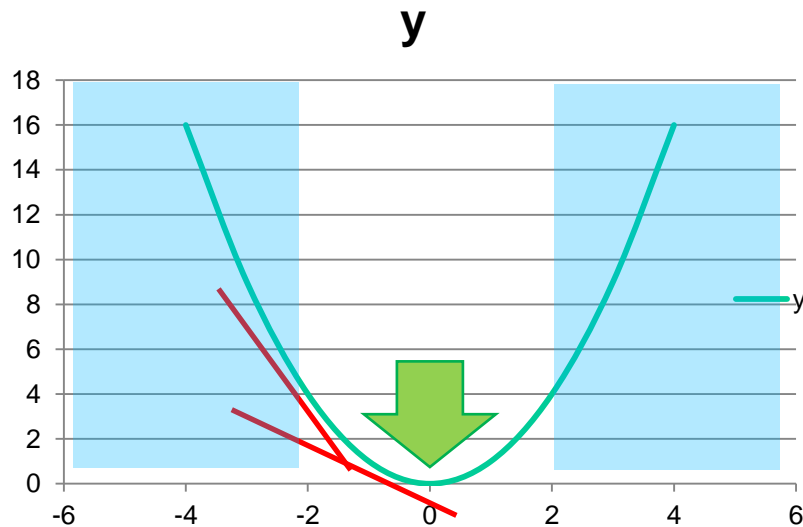
- In telemetrie:
 - Als-dan regels (rules)
 - Controllers (PI, interval,)
- Dus: feedback en/of feedforward
- Maar ook MPC gewenst ?
 - *wat zijn voor/nadelen van*
 - *Feed-Back*
 - *Feed-Forward*
 - *Model Predictive Control*

Doelfunctie

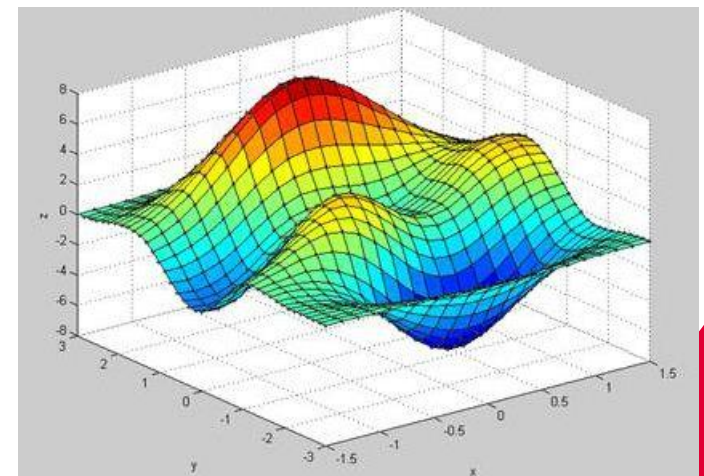
Zoek het minimum van een **objective function**

Bijv.: minimaliseer $y = x^2$

Gradient gebaseerd optimalisatie algoritme gebruik de helling

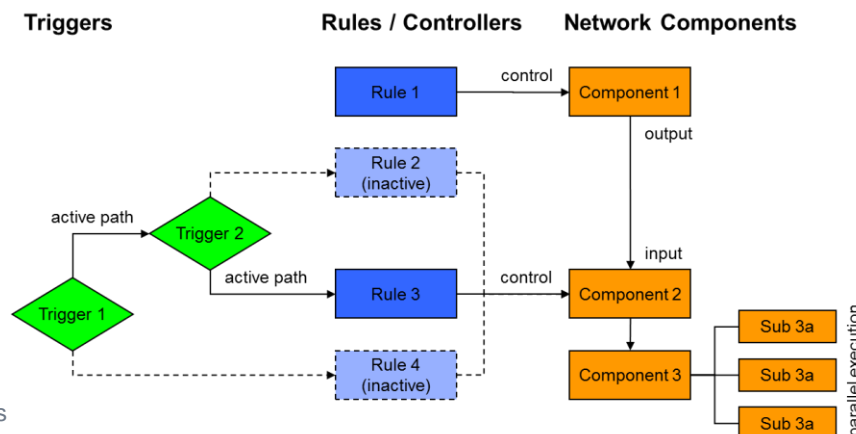


Bijv. 2 variabelen:



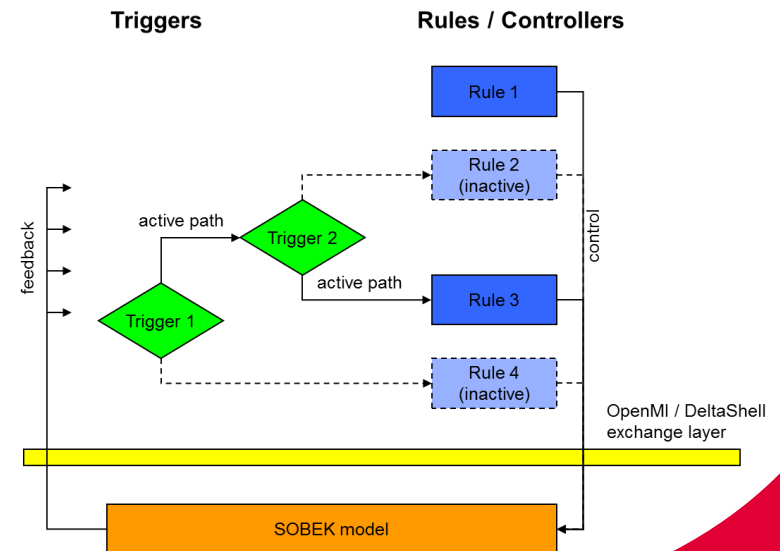
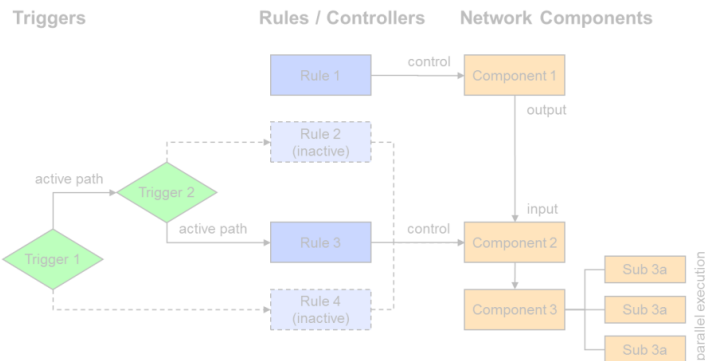
RTC-Tools: als losse module

- Rules, triggers
- MPC (optimalisatie)
- Externe koppelingen (Matlab, OpenDA, OpenMI)
- Interne modellen
 - Hydrologische (HBV, sacramento, ...)
 - Hydraulische (zoals Sobek-CF)
 - Reservoirs en stuwdammen



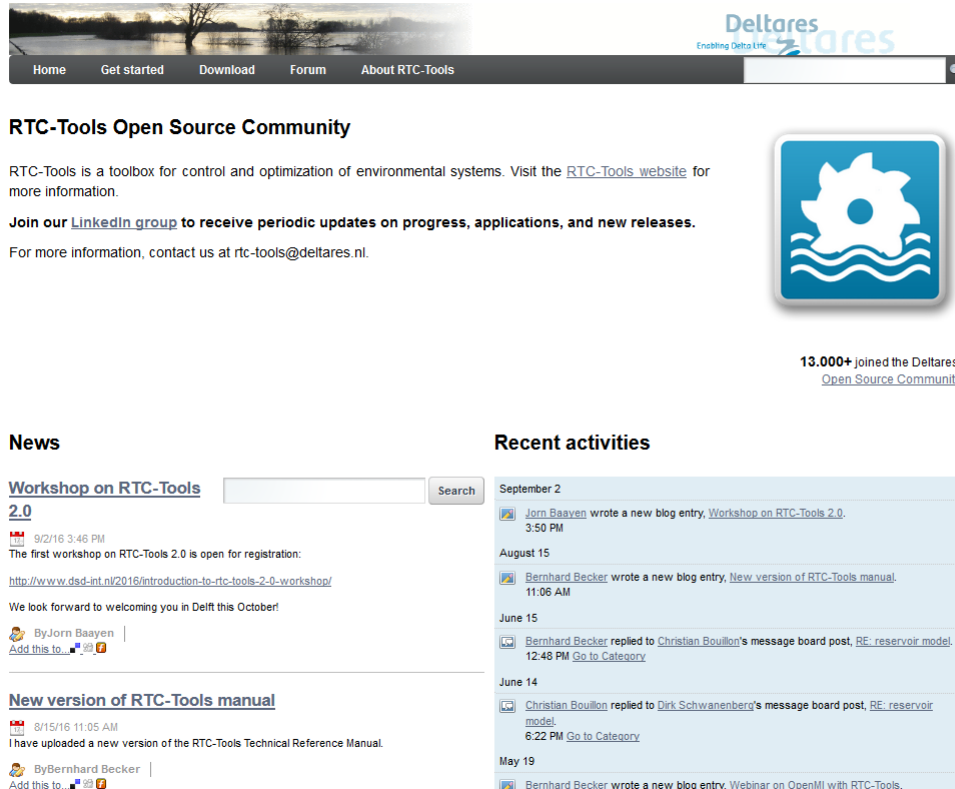
RTC-Tools: koppelingen

- Matlab, OpenDA, OpenMI
- RTC module van SOBEK 3.x
→ Alleen rules en triggers (FeedBack, FeedForward)



RTC-Tools community

- Open source: <http://oss.deltares.nl/web/RTC-Tools>



The screenshot shows the homepage of the RTC-Tools Open Source Community. At the top is a navigation bar with links: Home, Get started, Download, Forum, and About RTC-Tools. Below the navigation bar is a header image of a landscape with water and trees. The main content area is titled "RTC-Tools Open Source Community". It contains a paragraph describing RTC-Tools as a toolbox for control and optimization of environmental systems, a link to the website, and a link to a LinkedIn group. To the right of this text is a large version of the Deltares logo. Below the text is a statistic: "13.000+ joined the Deltares Open Source Community". On the left side, there is a "News" section with two articles: "Workshop on RTC-Tools 2.0" and "New version of RTC-Tools manual". On the right side, there is a "Recent activities" section showing a list of recent posts and replies from community members, dated from May 19 to September 2.

RTC-Tools Open Source Community

RTC-Tools is a toolbox for control and optimization of environmental systems. Visit the [RTC-Tools website](http://rtc-tools.deltares.nl) for more information.

Join our [LinkedIn group](#) to receive periodic updates on progress, applications, and new releases.

For more information, contact us at rtc-tools@deltares.nl.

13.000+ joined the Deltares Open Source Community

News

Workshop on RTC-Tools 2.0

9/2/16 3:46 PM
The first workshop on RTC-Tools 2.0 is open for registration:
<http://www.dsd-int.nl/2016/introduction-to-rtc-tools-2-0-workshop/>
We look forward to welcoming you in Delft this October!

By [Jorn Baayen](#)
[Add this to...](#)

New version of RTC-Tools manual

8/15/16 11:05 AM
I have uploaded a new version of the RTC-Tools Technical Reference Manual.

By [Bernhard Becker](#)
[Add this to...](#)

Recent activities

September 2
[Jorn Baayen](#) wrote a new blog entry, [Workshop on RTC-Tools 2.0](#).
3:50 PM

August 15
[Bernhard Becker](#) wrote a new blog entry, [New version of RTC-Tools manual](#).
11:06 AM

June 15
[Bernhard Becker](#) replied to [Christian Bouillon's](#) message board post, [RE: reservoir model](#).
12:48 PM [Go to Category](#)

June 14
[Christian Bouillon](#) replied to [Dirk Schwanenberg's](#) message board post, [RE: reservoir model](#).
6:22 PM [Go to Category](#)

May 19
[Bernhard Becker](#) wrote a new blog entry, [Webinar on OpenMI with RTC-Tools](#).



RTC-Tools versie 1.x

Versie 1.4:

- Geen user interface
- Definitie in XML bestanden
- Continue optimalisatie

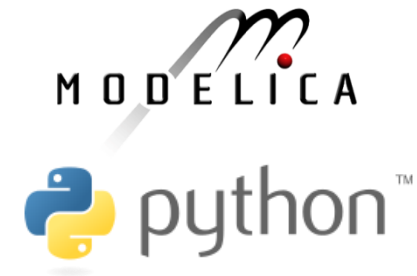
Versie 2.0:

- user interface met modelica
- Definitie in XML bestanden

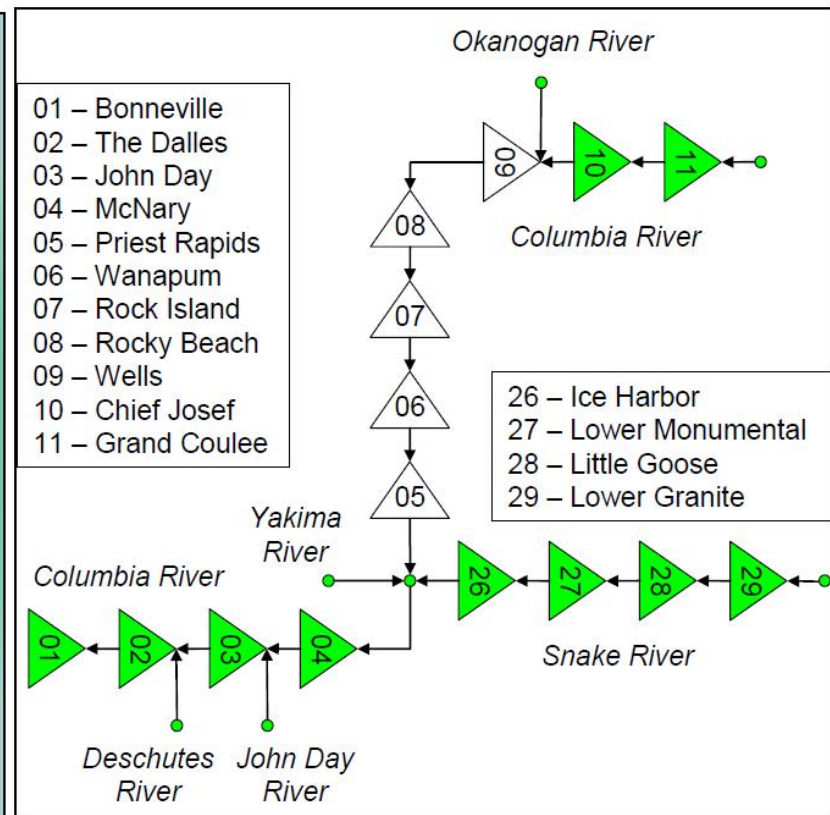


RTC-Tools versie 2.0

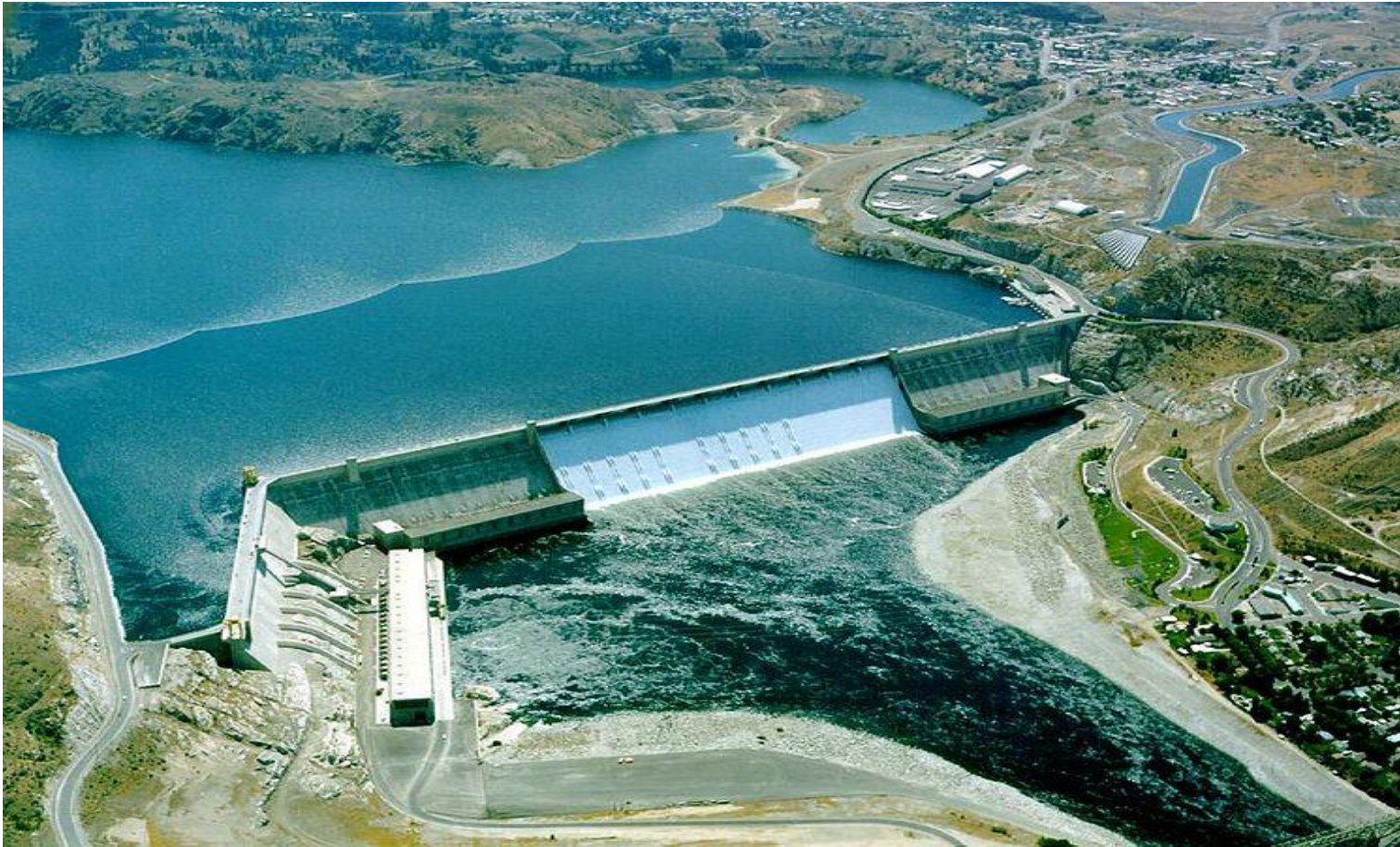
- ontwikkeld in kader van TKI
 - user interface met modelica
 - koppeling met python
-
- inhoudelijk
 - Multi-objective functions
 - Treebased optimalisatie (onzekerheden)
 - Mixed-Integer optimalisatie



Voorbeeld Bonneville Power Admin.



Voorbeeld Bonneville Power Admin.





Voorbeeld Bonneville Power Admin.

Afweging van:

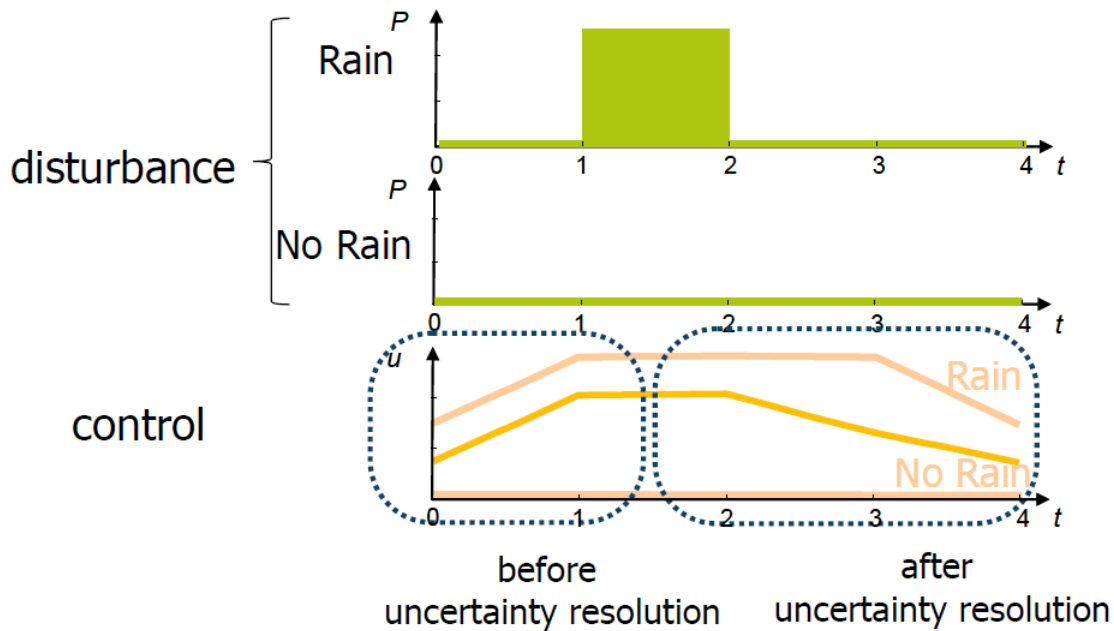
- Berging in reservoirs
- Peilen en peilvariatie
- Elektriciteitsvraag
- Scheepvaart
- Natuur / ecologie (zalmtrek!)
- Prioritering

Actuele innovatieprojecten in NL

- TKI project “Multi-stage Stochastic and Robust Optimization of Flood Mitigation Measures under Forecast Uncertainty” (Dirk Schwanenberg): Fundamenteel onderzoek naar onzekerheid in voorspellen en getrapte optimalisatie
→ **bouw** RTCTools v2
- TKI project “Rekenen aan Slim Water Management” (Klaas-Jan van Heeringen): vervolg op bovenstaande, brede toepassing van korte termijn optimalisatie bij 4 waterbeheerders
→ **toepassen** RTCTools v2
- “Water-Energy-eXchange” (WEX) (Ivo Pothof + KJvH): optimalisatie van energieverbruik (CO_2 en kosten) in NL waterbeheer, in samenwerking met energieleveranciers

Treebased Optimization

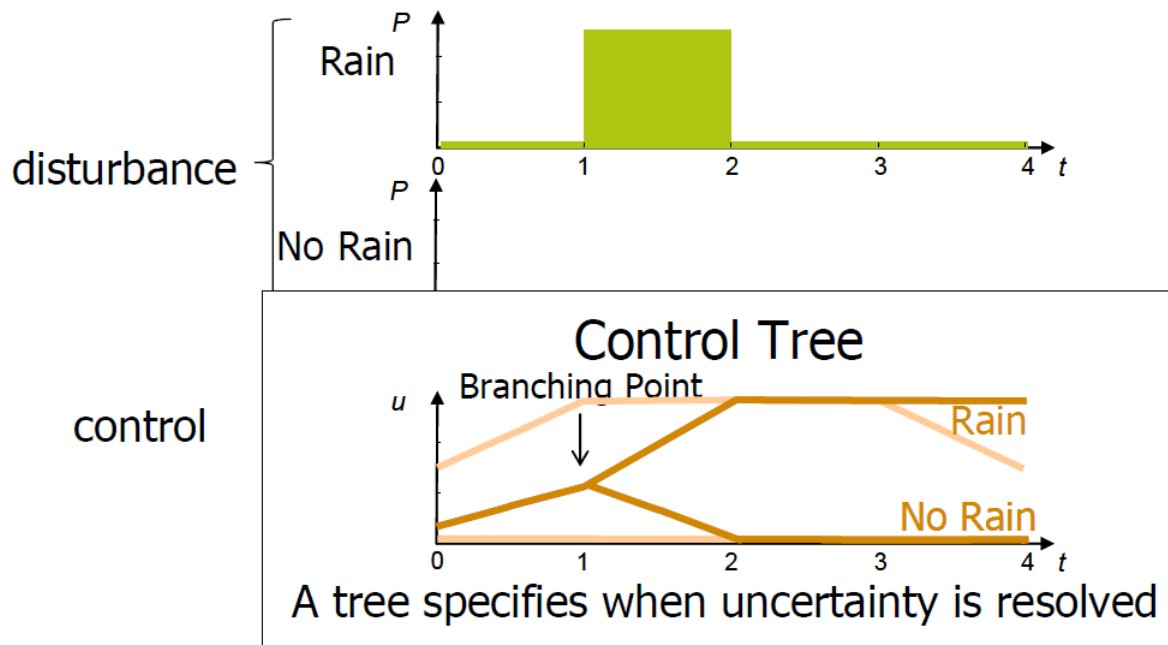
Decision Uncertainty Resolution Decision



Once uncertainty is resolved, it is possible to adopt the control strategy optimal to the remaining scenario !!!

Treebased Optimization

Decision Uncertainty Resolution Decision



Once uncertainty is resolved, it is possible to adopt the control strategy optimal to the remaining scenario !!!



Meer informatie

<http://oss.deltares.nl/web/RTC-Tools>

rtc-tools@deltares.nl