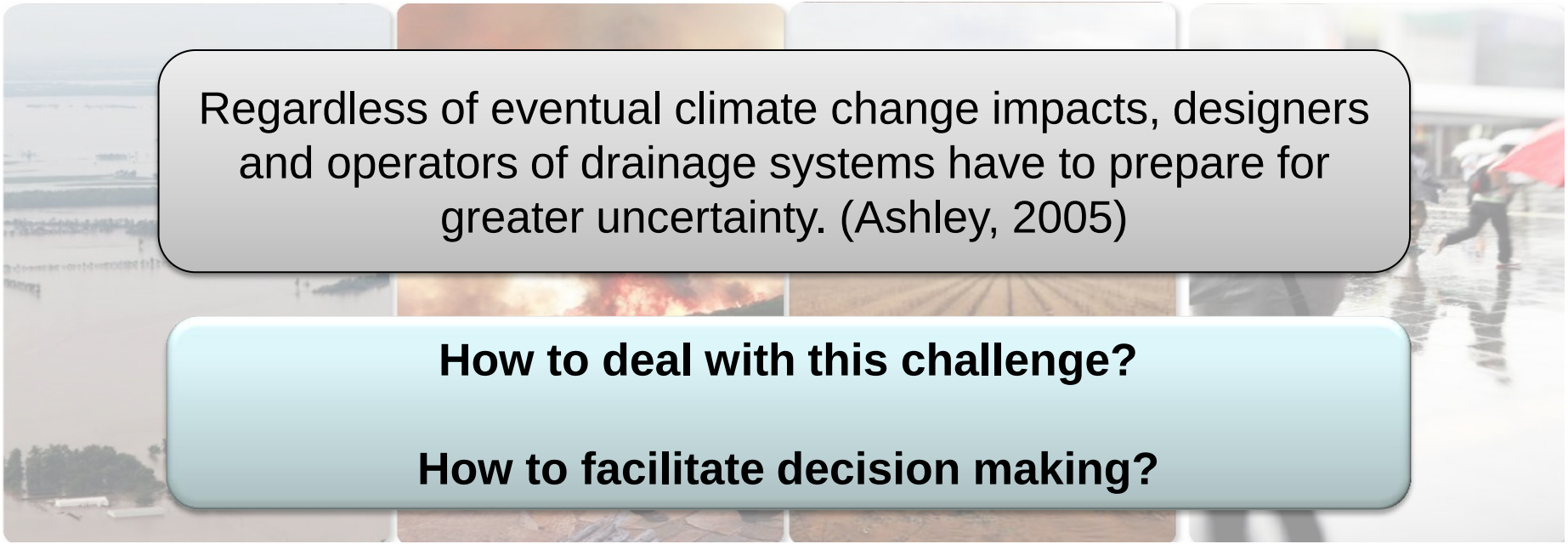
Assessment of Combined Sewer Overflows under Climate Change

Urban Drainage Pilot Study Linz

Valentin Gamerith, Jonas Olsson, David Camhy
Martin Hochedlinger, Peter Kutschera,
Sascha Schlobinski and Guenter Gruber

Introduction



Regardless of eventual climate change impacts, designers and operators of drainage systems have to prepare for greater uncertainty. (Ashley, 2005)

How to deal with this challenge?

How to facilitate decision making?

IPCC
http://www.ipcc.ch/news_and_events/docs/srex/SREX_slide_deck.pdf

Project SUDPLAN

- EU FP 7 project
  Sustainable Urban Development Planner for Climate Change Adaptation
- Web-based decision support platform
- Supports planning and decisions in urban infrastructure for extreme events due too climate change effects
- 4 pilot studies (air quality, flooding and combined sewer overflows)

Introduction – Pilot Study Linz

Google Maps

- **Effects of climate change scenarios on combined sewer overflow loads**
- **Assessment according to Austrian guidelines**
  - **Estimation of efficiency rates hydraulic and particulate pollutants**

Introduction –Linz Catchment

Linz AG

- **Total area ~ 900 km²**
- **Wastewater treatment plant: downtown Linz and 39 neighbour communes**
- **950 000 PE , high industrial contribution**
- **Receiving Waters: Danube, Traun, Enns**

Introduction – Linz Catchment

- Combined & separate system
- Partly real time controlled (since 2005)
- Several CSO tanks
- Total estimated storage volume 115 000 m³
- Primary clarifiers on WWTP work as CSO tanks during combined sewer flow


CSO tank Plesching

Photos: Wendner


CSO tank Weikerlsee

Methods – Austrian RB19 Guideline

- **Efficiency rate η:**
  - Percentage of stormwater runoff routed to WWTP on average
- **Required efficiency rates:**
  - For dissolved (η_d) and particulate pollutants (η_p)
  - Based on $r_{720,1,}$ PE and ratio combined/separate system
- **Actual efficiency rate**
  - Calculated by simulation model (long term simulations)
  - sedimentation efficiency η_{sed} for particulate pollutants

Methods – Austrian RB19 Guideline

Actual efficiency rate > Required efficiency rate

Efficiency ratio $\nu = \eta_{req} / \eta_{act}$

η_{req} … Required efficiency rate

η_{act} … Actual efficiency rate from simulation

$\nu > 1{,}0$ → requirements met

Methods – Sewer System Model

- Aggregated model in SWMM 5
- All relevant structures included
  - 43 combined sewer overflows
  - estimated sedimentation-efficiency 20 %
- Global sensitivity analysis and automated model calibration
- 1 year simulation: 20 minutes simulation time

Gamerith et al. (2011)

Methods – Rainfall

- **Two rainfall time series, 14 years**
  - **Historical time series from downtown Linz**
  - **Predicted time series**
    - downscaling of historical time series with climate model ECHAM5 (SMHI) and A1B emission scenario
    - Increase from September to May
    - Decrease from June to August
    - General increase of peak intensities

Methods – Rainfall

- **Two rainfall time series, 14 years**

Time series	Period	Precipitation depth	$r_{720,1}$	Required efficiency rates	
				η_d	η_p
-		mm/a	mm	%	%
historical	01.01.1993 01.01.2007	850	35.1	57.4	72.4
predicted	01.01.2079 01.01.2093	918	39.3	55.4	70.4

Methods – Rainfall

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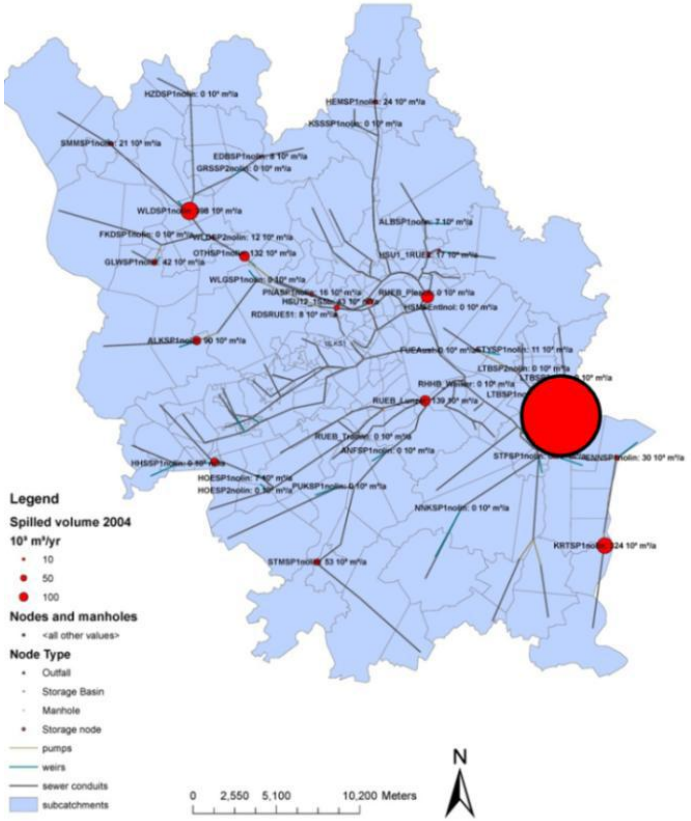
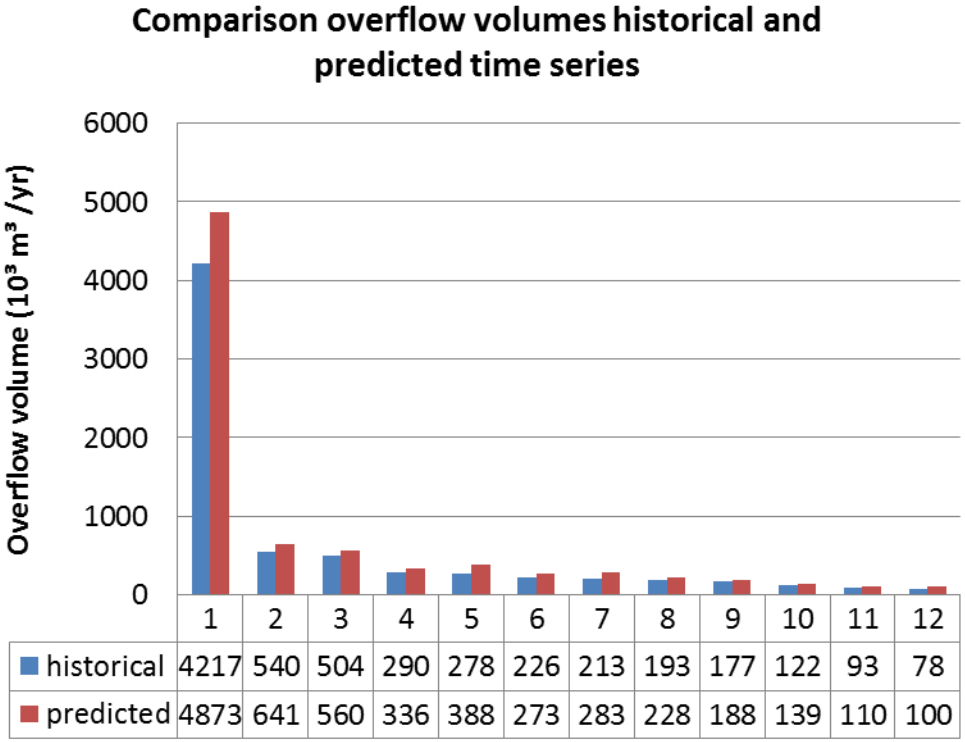
		+ 8 %	**+12 %**	**-2 percentage points**	

Results - CSOs

- First evaluation:
  - Simulation with 1 year from historical time series
  - Comparison of overflow volumes
- 12 CSOs approx. 95 % of total overflow volume
- Primary clarifiers: approx. 60 %



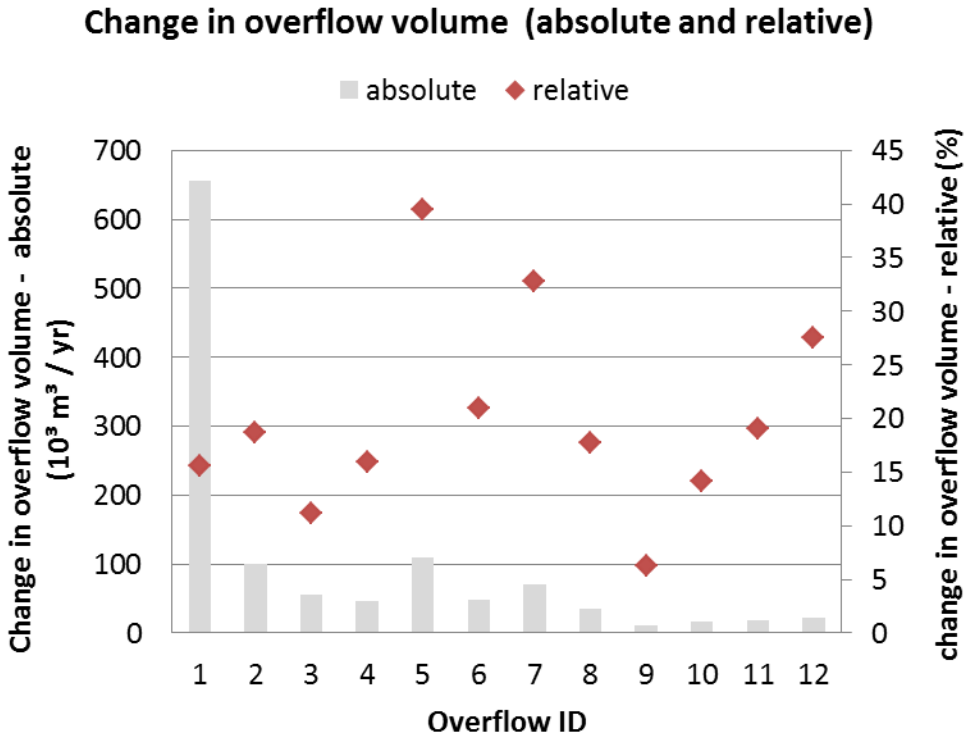
Results - CSOs



	1	2	3	4	5	6	7	8	9	10	11	12
historical	4217	540	504	290	278	226	213	193	177	122	93	78
predicted	4873	641	560	336	388	273	283	228	188	139	110	100

- 12 relevant CSOs
- Sorted by overflow volume
- In general: increase in overflow volume

Results - CSOs



- **Relative changes +5 to +40 %**
- **Primary clarifiers approx. +15 %**
- **Total overflow volume +17 %**

Results – Efficiency Rates

Time series		Required efficiency rate	Actual efficiency rate	Efficiency ratio
		%	%	-
Historical	η_d	57.4	67.4	**1.17**
	η_p	72.4	73.9	**1.02**
Predicted	η_d	55.4	64.5	**1.16**
	η_p	70.4	71.3	**1.01**

Results – Efficiency Rates

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Predicted	η_d	55.4	64.5	**1.16**
	η_p	70.4	71.3	**1.01**
		-2 percentage points	**approx. - 3 percentage points**	**Met in both cases**

Results – Efficiency Rates

Time series		Required efficiency rate	Actual efficiency rate	Efficiency ratio
		%	%	-
Hi				1.17
				1.02
Pr				1.16
				1.01
				Met in both cases

- Closely met for particulate pollutatnts
- Impact of estimated sedimentation efficiency!

Estimation of CSO sedimentation efficiency

- Sensors at primary clarifiers
- Inflow and outflow: Q, TSS_{eq}, COD_{eq}
- Evalutaion of combined sewage flows
- Integration in SUDPLAN platform

Conclusions

- Pilot Study Linz in SUDPLAN project: Impact of climate change scenario on combined sewer overflows
- Comparison of 2 scenarios in long term simulations
  - 12 of 43 CSO significant contribution
  - WWTP highest impact (60 %)
- Predicted time series
  - Increase in total overflow volume of 17 %
  - Requirements Austrian guidelines met

Conclusions

- **Impact of estimated sedimentation efficiency**
  - Requirements not met when decreased
  - Not easily assessable for complex system
  - Sensors installed for estimation in major CSO tank

- **Future work**
  - Currently additional climate change scenarios evaluated
  - Full integration in Scenario Management System

  www.sudplan.eu