Multiple pressures on the Göta River and the city of Gothenburg, Sweden – management by stakeholder involvement

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ARCH

SEVENTH FRAMEWORK PROGRAMME

IVL Swedish Environmental Research Institute

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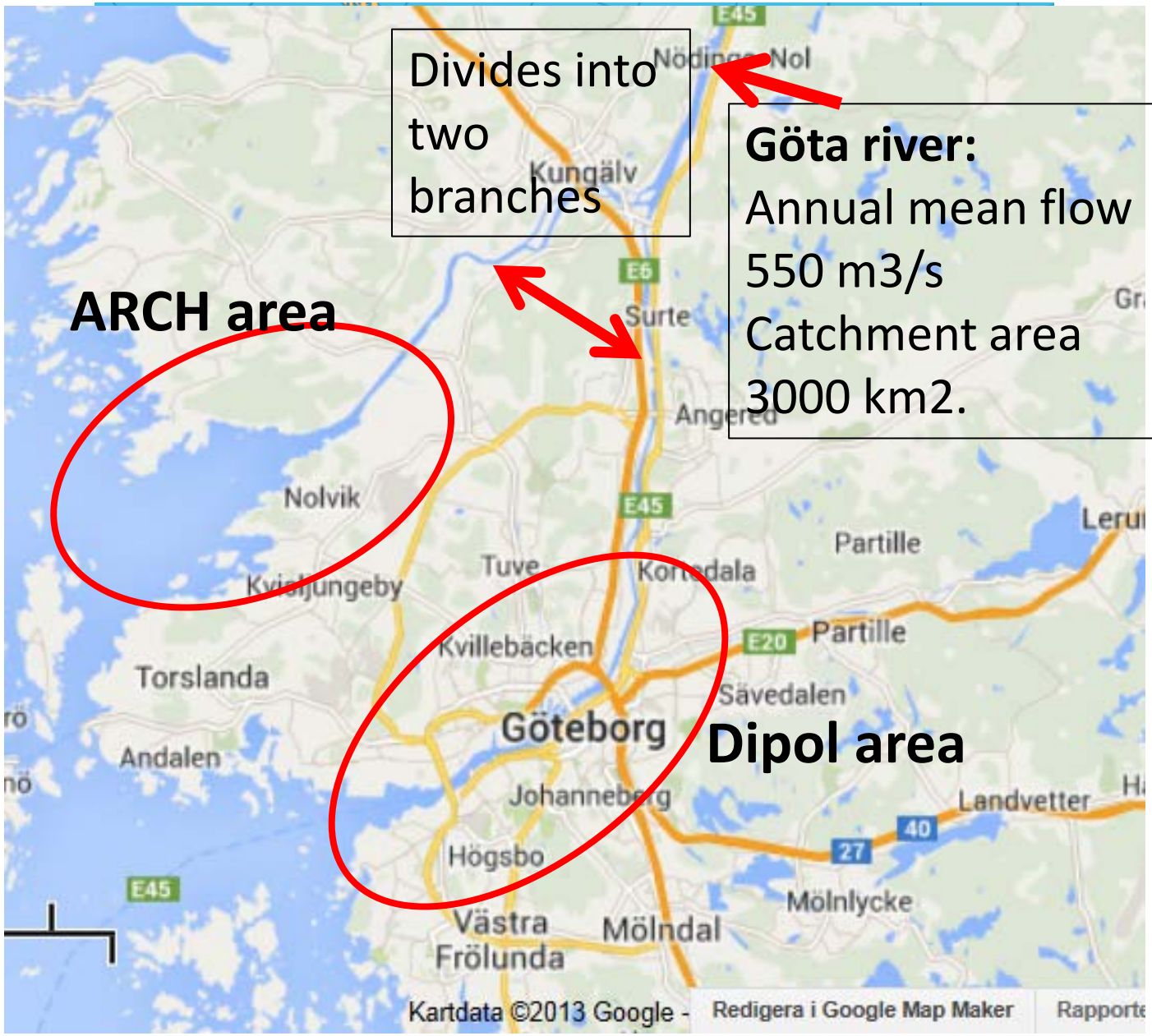
The Interreg IVB North Sea Region Programme

Many urban areas face a number of future potential problems

For example **environmental**, **social** and **economic** problems together with the, often not fully, defined **effects of climate change** and **urban densification**.

In addition some of these issues are assumed to sometimes **interact** and sometimes **counteract** with each other.

Investi-gation area
Gothenburg
Sweden



Major climate change effects in the region

"Direct" effects:

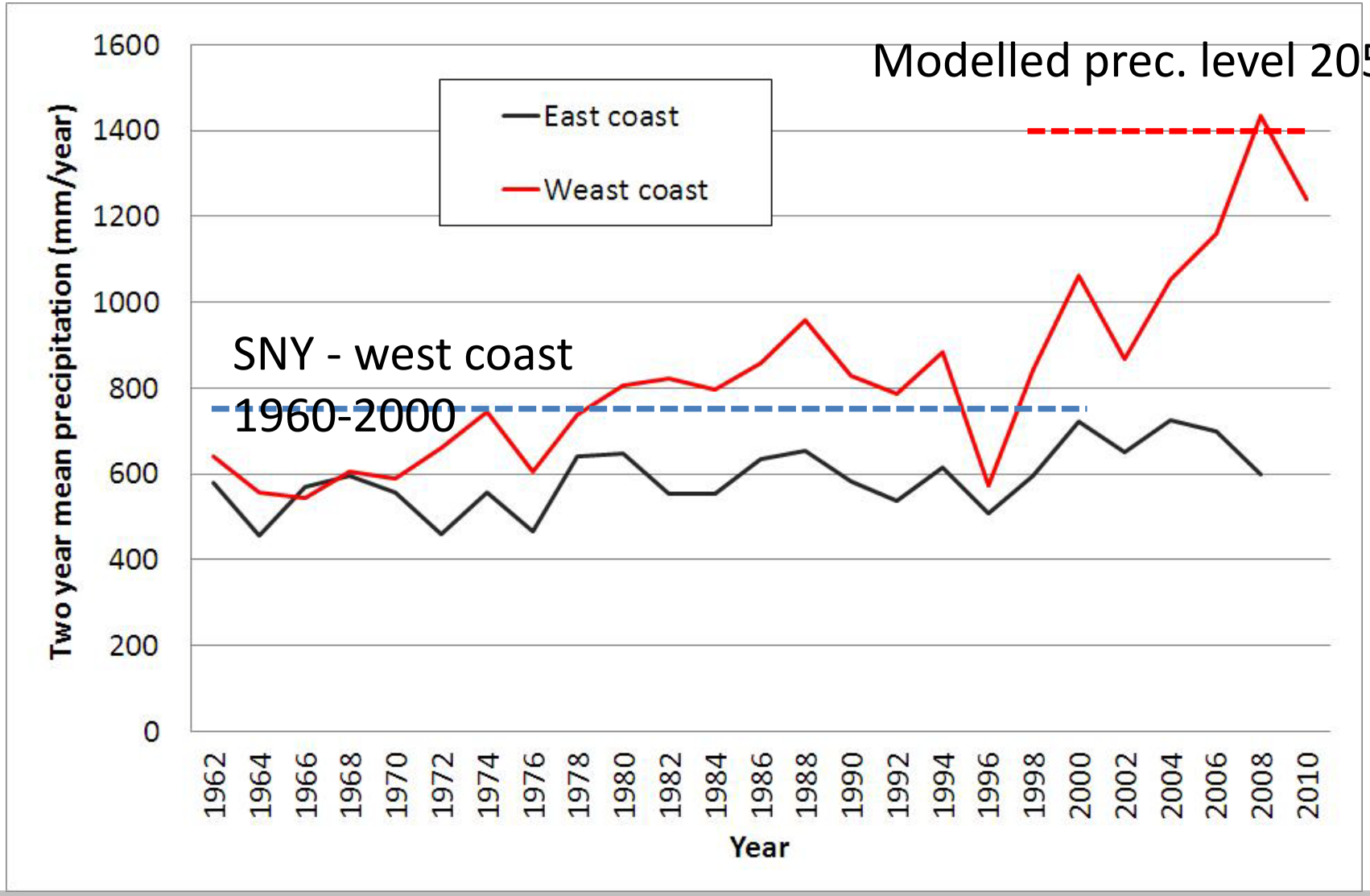
- Increased precipitation
- More storms
- Changed seasonality

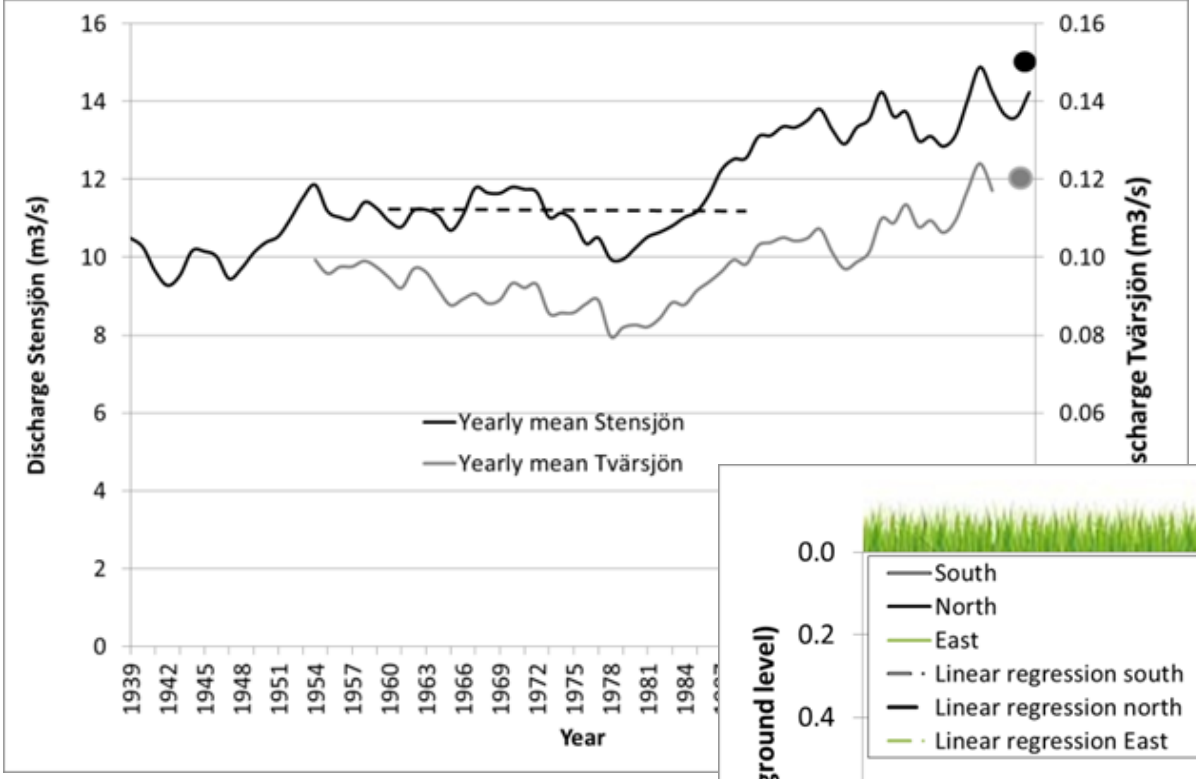
Foto: LEIF JACOBSSON

(Possibly) leading to:

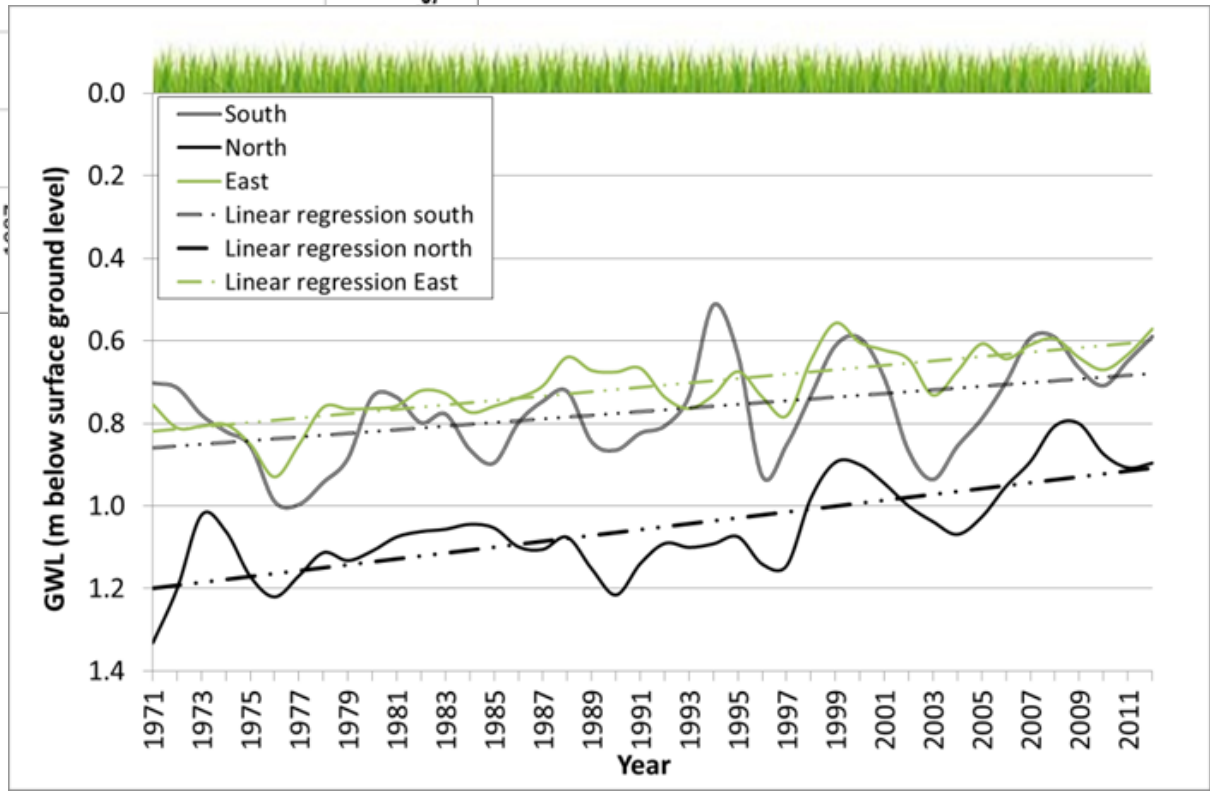
- Increased river discharge
- Higher sea levels (during storms)
- More frequent flooding
- Increased particle transport and riverbank erosion
- Higher water pollution conc.
- More sedimentation in the estuary
- Risk of salt water intrusion in the city fresh water inlet
- Increased ground water levels
- Increased leakage from soils

Present status - from measurements





Seen on both the **river discharge** and the **ground water levels**



In prep. Haeger-Eugensson et al. (2013)

Future plans for the Gothenburg area

Growth through urban densification, both within the city itself and in surrounding suburbs

May enhance the effects from the climate change e.g. due to changed land-use such as more paved surfaces and build up areas

How to best “attack” such complex system?

How will climate change effect the urban and coastal waters for the Gothenburg area

together with some of the positive and negative effects of urban densification.

For this a sensitivity model was used and applied for the Gothenburg urban area including a stakeholder process

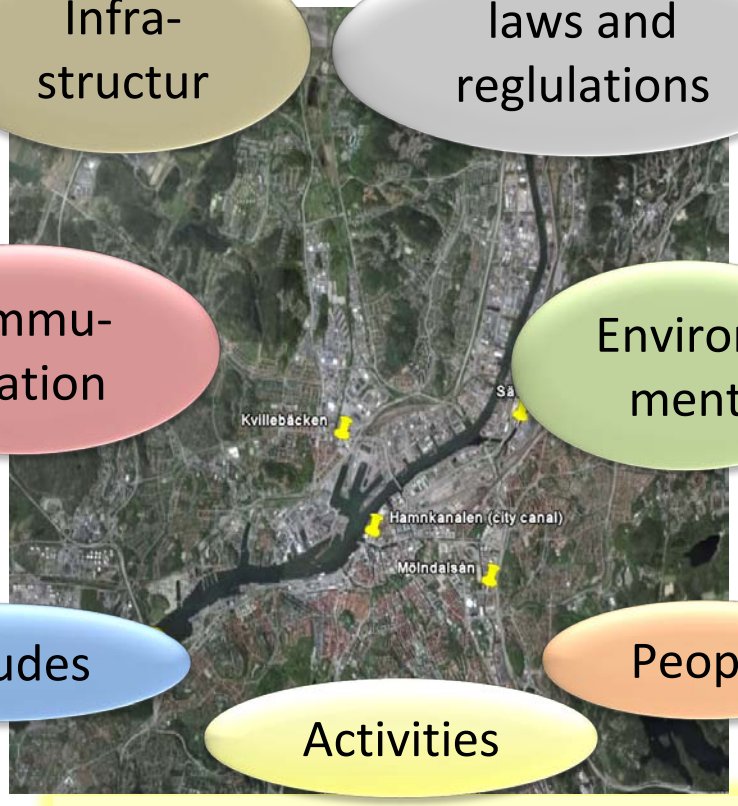
Identifying the system *(included in most complex systems according to the "Vester method")*

- *construction*
- *housing*
- *Land-use*

Infra-structur

laws and reglulations

- *taxes*
- *measures*
- *planing*



- *Transport*
- *Telekommu-nication*
- *Traffic*

Commu-nication

Environ-ment

- *energy*
- *water*
- *waste*
- *resource con-sumption*
- *climate*

Attitudes

People

Activities

- *social structures*
- *education*

- *livlehood - economy*
- *production - investments*

- *inhabitants*
- *tourists*
- *visitors.*

Definding water system variables
and ranking the impact on each other

1. State of the estuary

3 – highest impact

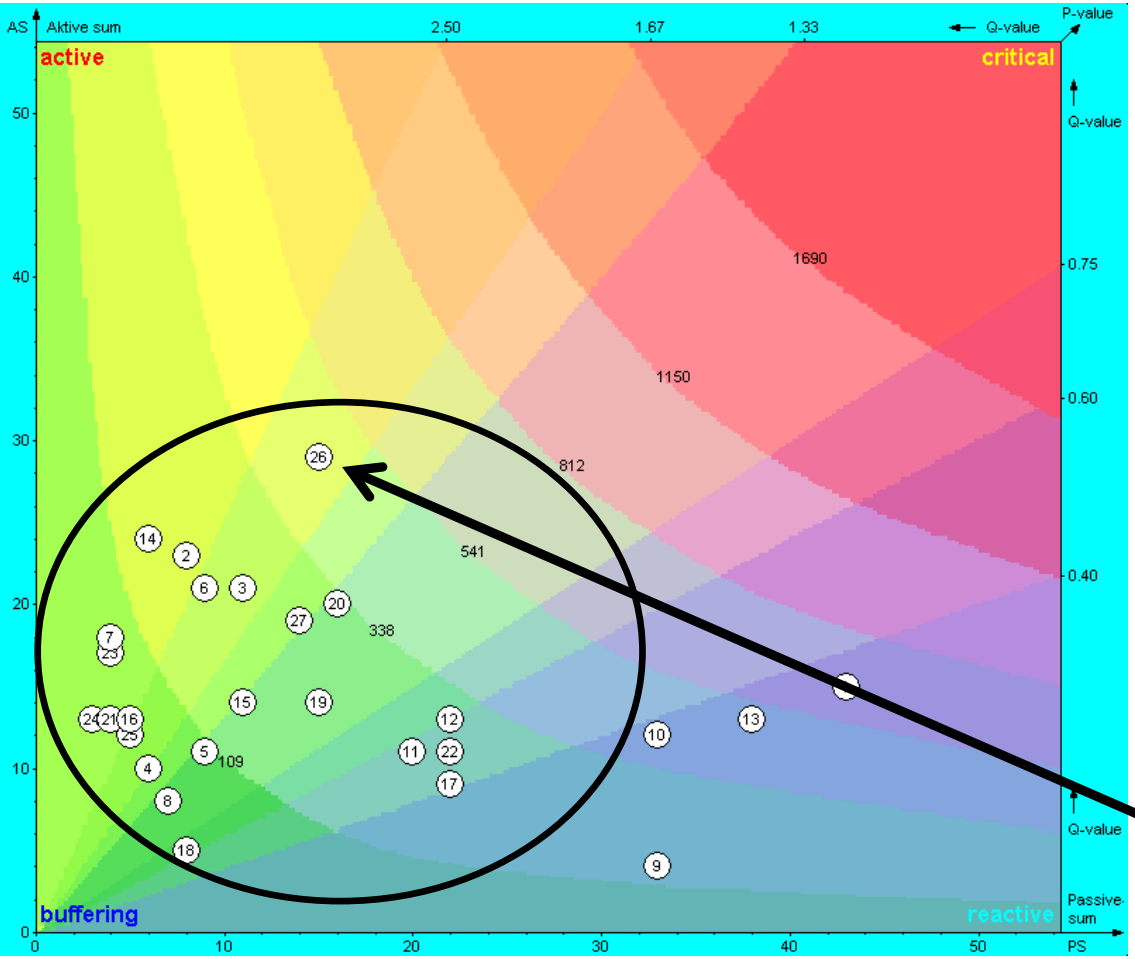
26. Environmen-tal measures

Influence by variable ↓ on variable →		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	AS	P
1	Tillståndet estuariet	X	0	1	0	1	0	0	0	2	3	0	1	2	1	0	0	2	0	0	0	0	0	0	0	0	1	1	15	645
2	Flödesvariation ytvattenflöde	2	X	1	0	0	0	0	0	1	3	0	3	3	1	0	0	3	3	0	2	0	1	0	0	0	0	0	23	184
3	Ekonomisk tillväxt	0	0	X	2	1	3	1	1	2	0	2	0	0	0	3	1	0	0	0	1	0	3	0	0	0	1	0	21	231
4	Populationsdensiteten	0	0	0	X	0	0	0	0	2	0	0	0	0	0	1	1	0	0	3	0	1	0	1	1	0	0	0	10	60
5	Antal besökande	1	0	1	0	X	0	0	0	1	0	0	0	1	0	2	0	0	0	2	0	0	1	0	0	0	1	1	11	99
6	Populationsmängd	2	0	1	2	1	X	0	0	1	1	2	1	1	0	2	0	0	0	2	2	0	2	0	0	0	0	1	21	252
7	Individuellt ansvarstagande	2	0	0	0	0	0	X	2	2	1	1	0	2	0	2	0	0	0	1	1	0	2	0	0	0	2	0	18	72
8	Kunskapsnivå	0	0	0	0	0	0	1	X	1	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	1	1	8	56
9	Livskvalitet	0	0	0	0	1	1	1	0	X	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	132
10	Kvaliteten ekosystemtjänster	3	0	1	0	1	0	0	0	2	X	0	0	1	0	0	0	2	0	0	0	0	1	0	0	0	0	1	12	396
11	Mängd deposition från luft	1	0	0	0	0	0	0	0	2	2	X	1	2	1	0	0	0	0	0	0	0	0	1	0	0	1	0	11	220
12	Mängd utsläpp fr. mark /sedim.	3	0	0	0	0	0	0	0	1	2	0	X	3	0	0	0	3	0	0	0	0	0	0	0	0	1	0	13	286
13	Vattenkvalitet	3	0	0	0	1	3	0	0	3	2	0	0	X	1	0	0	0	0	0	1	0	0	0	0	0	1	1	16	608
14	Lagstiftning och tillsyn	3	1	0	0	0	0	0	0	1	1	3	1	3	X	0	1	2	0	1	3	0	1	0	0	0	2	1	24	144
15	Transportmängd	1	0	0	0	0	0	0	0	1	0	2	1	2	1	X	0	1	0	1	0	0	3	0	0	0	1	0	14	154
16	Kapacitet miljövänl. transport	2	0	0	0	0	0	0	0	1	1	2	1	2	0	0	X	1	0	1	0	0	2	0	0	0	0	0	13	65
17	Sedimenttransport	3	0	0	0	0	0	0	0	0	3	0	0	2	0	0	0	X	0	0	0	0	0	0	0	0	1	0	9	198
18	Grundvattennivåfluktuation	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	1	X	0	0	0	0	0	0	0	0	0	5	40
19	Mängd infiltrationsytor	1	1	0	0	0	1	0	0	1	1	2	2	1	0	0	0	1	1	X	1	1	0	0	0	0	0	0	14	210
20	Kapac./effektivtet reningsverk	3	0	0	1	0	3	0	0	3	3	0	2	3	0	0	0	1	0	0	X	0	1	0	0	0	0	0	20	320
21	Avvikelse från temp.mönster	2	2	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	1	0	0	X	0	1	1	1	0	1	13	52
22	Resursförbrukning	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	1	X	1	1	1	0	1	11	242
23	Avvikelse fr. nederbördsmön.	2	3	1	0	0	0	0	0	1	1	2	1	1	0	0	0	1	1	0	1	1	0	X	0	0	0	1	17	68
24	Stormfrekvens	3	0	0	0	0	0	0	0	0	2	0	1	2	0	0	0	1	0	0	0	0	0	0	X	3	0	1	13	39
25	Havsvattennivåförändringar	3	0	2	0	0	0	0	0	1	1	0	1	0	0	0	0	1	1	0	1	0	0	0	0	X	0	1	12	60
26	Miljöförbättrande åtgärder	3	1	1	1	1	0	0	1	2	3	3	2	2	0	0	1	2	1	1	1	0	1	0	0	0	X	2	29	435
27	Informationsaktiviteter	0	0	1	0	2	1	1	3	0	0	0	0	2	1	1	1	0	0	1	1	0	2	0	0	0	2	X	19	266
		43	8	11	6	9	12	4	7	33	33	20	22	38	6	11	5	22	8	15	16	4	22	4	3	5	15	14	PS	
		35	288	191	167	122	175	450	114	12	36	55	59	42	400	127	260	41	62	93	125	325	50	425	433	240	193	136	Qx100	

Consensus: A B C D E F

Compare with: A B C D E F

The presented result shows if the variables are *buffering, active or critical*

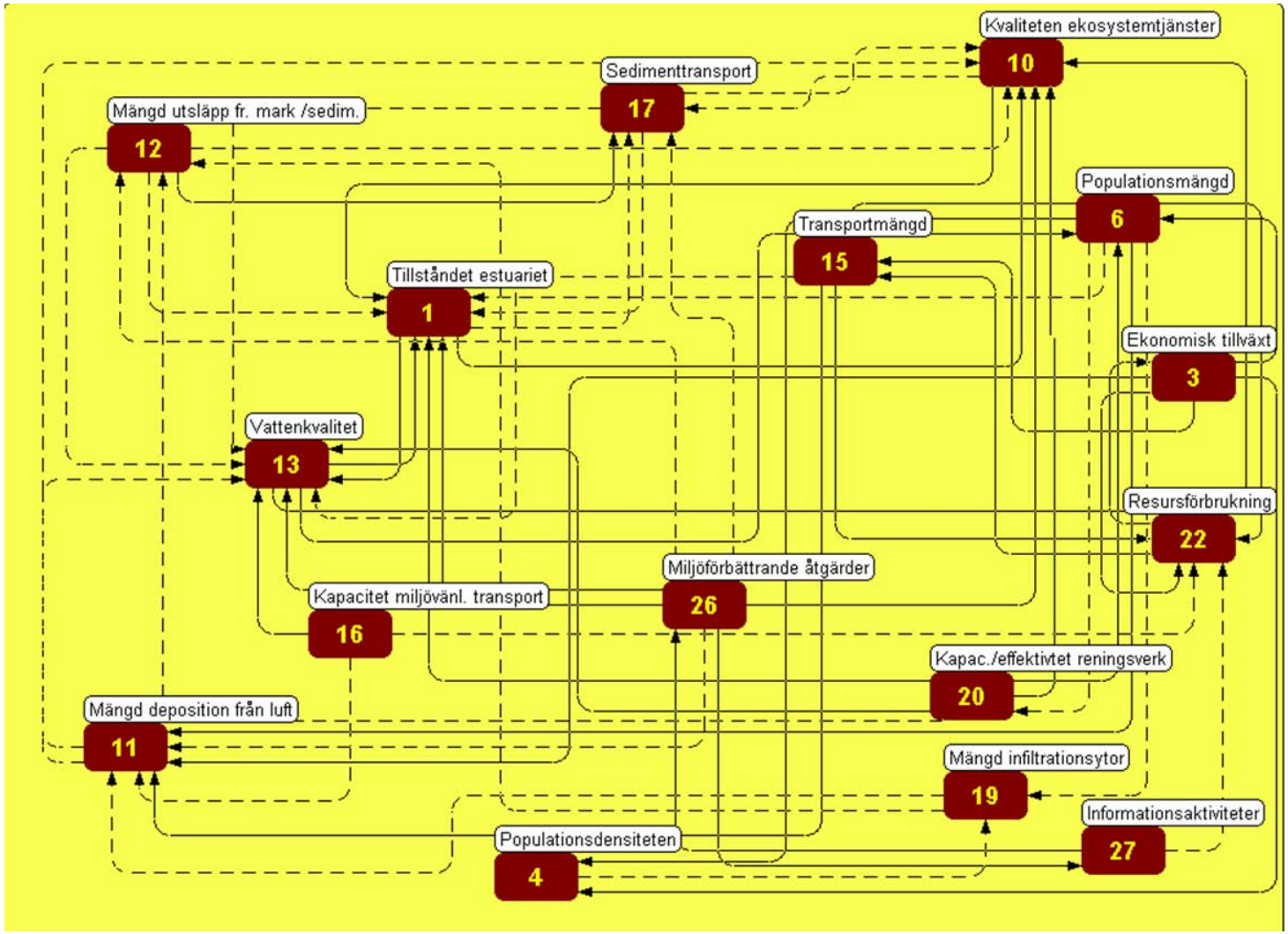


Based on the location of the variables in the diagram this is defined as a buffering and rather inert system.

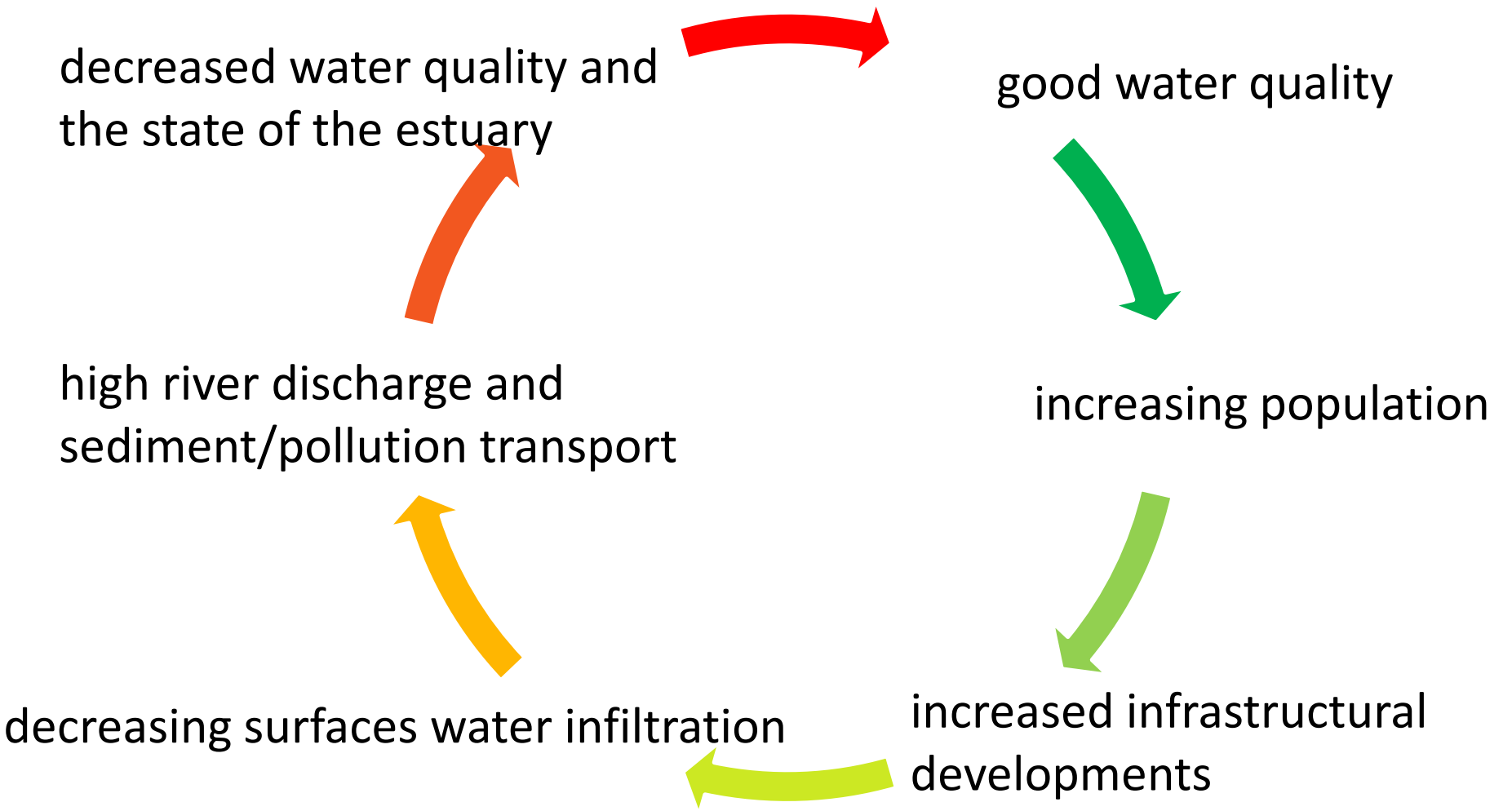
It is also stable and thus difficult to change locally, since there are only a few and not very active variables to ”work” with (e.g. 26 Environmental measures)

Feedback analyses

The active variables are further analysed of their internal connections, and which direction and strength the connection has.



A simple example: Effect on the estuary now and in future



Some key findings :

- The **estuary** is an end point for many feedback cycles why closer analysis are recommended e.g. contiguous measurements to detect negative changes with time.
- The capacity of the **sewage treatment plants** has nearly reached the limits why a further **population growth** can be costly since new ones has to be built.
- Increased **population grow** also risk to result in less infiltration surface and thus has to be planed carefully, since the risk of flooding and deteriorated **water quality** is already an issue due to the climate change.
- **Information activities** and gaining acceptance of **environmental improvement measures** has also been found to give a noticeable effect (variable 7).
- It is thus also important with information activities to increase **knowledge** and degree of **personal responsibility**

Thank you for your attention!