Economic and institutional issues related to sustainable sanitation

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- Comparison of ecological and conventional systems – summing up
- Decision making and institutions
- Discussion – what can we do and conclusions

Today's 'big idea'

- Theoretically
  - Nutrients in domestic wastewater and organic waste are almost suffient to fertilize the crops needed to feed the world population (Wolgast 1993)
- Practically
  - From rural to urban: Flow of nutrients and resources
  - From urban to rural: We can recycle human waste (faeces and urine plus grey water from domestic use) to produce clean water and fertilisers, and energy.
- If we do this…
  - We can reduce pollution, artificial fertiliser use, and consumption of non-renewable energy, and better cope with water shortages.
  - We can increase the return of organic matter to soils and so help water (and nutrient) retention
  - We can use decentralised and self-managed solutions

This idea has enormous potential benefits for agriculture

- Organic matter is often depleted in tropical soils and in modern farming dependent on chemical fertilisers
- The ability to produce all or most of nutrients needed for sustained food production increases incomes to farmers
- Greater self-sufficiency in relation to nutrients reduces input-cost risks
- Food production can be increased in dry-land farming and on tropical soils, where it is most needed.

This idea has enormous potential benefits for rural communities

- Human waste recycling and water supply is decentralised, and local control over these and related services is increased
- The recycled products return to the local economy and environment
- The investment in goods and services, as well as recurrent inputs can often be locally sourced
- Local employment and incomes are strengthened
- Local institutions are strengthened and social capital is increased
- A more sustainable development follows…

BUT!

- There is considerable professional, official and personal ‘resistance’ to this ecological system. Why?
- Several different possible reasons
  - private costs and benefits
  - vested interests in conventional system
  - sewage etc. a ‘non-topic’ for discussion – cultural resistance
  - Risk of pollutant matter by recycling
  - lack of trust in locally self-managed systems – “tragedy of the ‘commons’”.

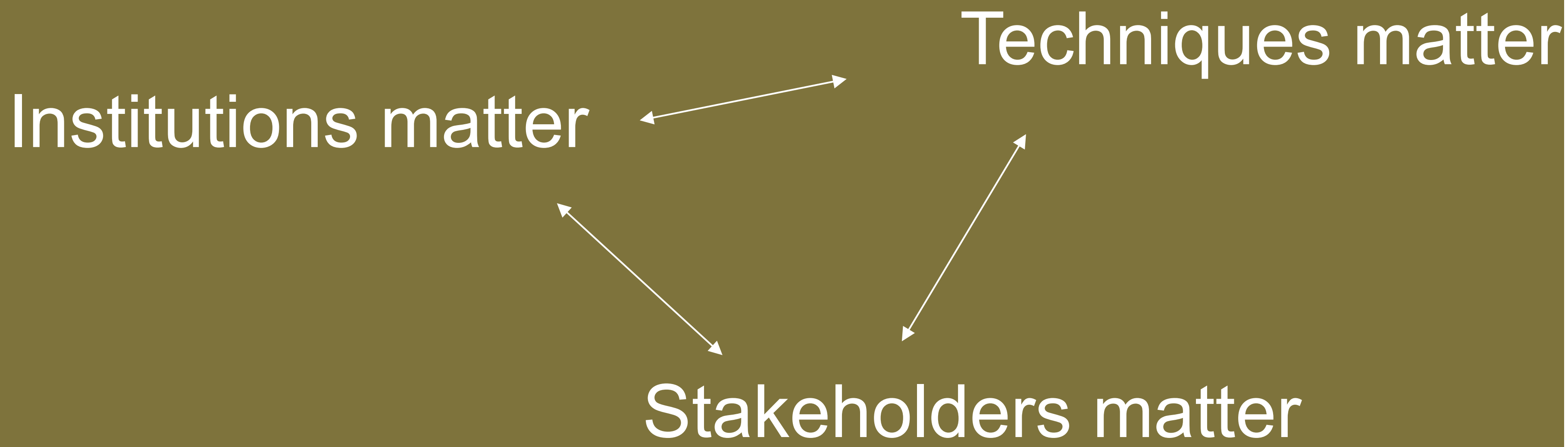
Economics is about decision making and evaluation

- Choices
  - construct our living and affect the conditions for others
  - Made by individuals and collectives
- The right choice?
  - Choosing implies to change or preserve
  - => necessary, favorable or right
- Evaluations and assessments
  - Physical consequences of a project or change in institutional structure
  - Which consequences are important and valuable
  - Rights or moral commitments involved going beyond the direct assessment of consequences
- To assess economically – is to utilize the resources in the most efficient way

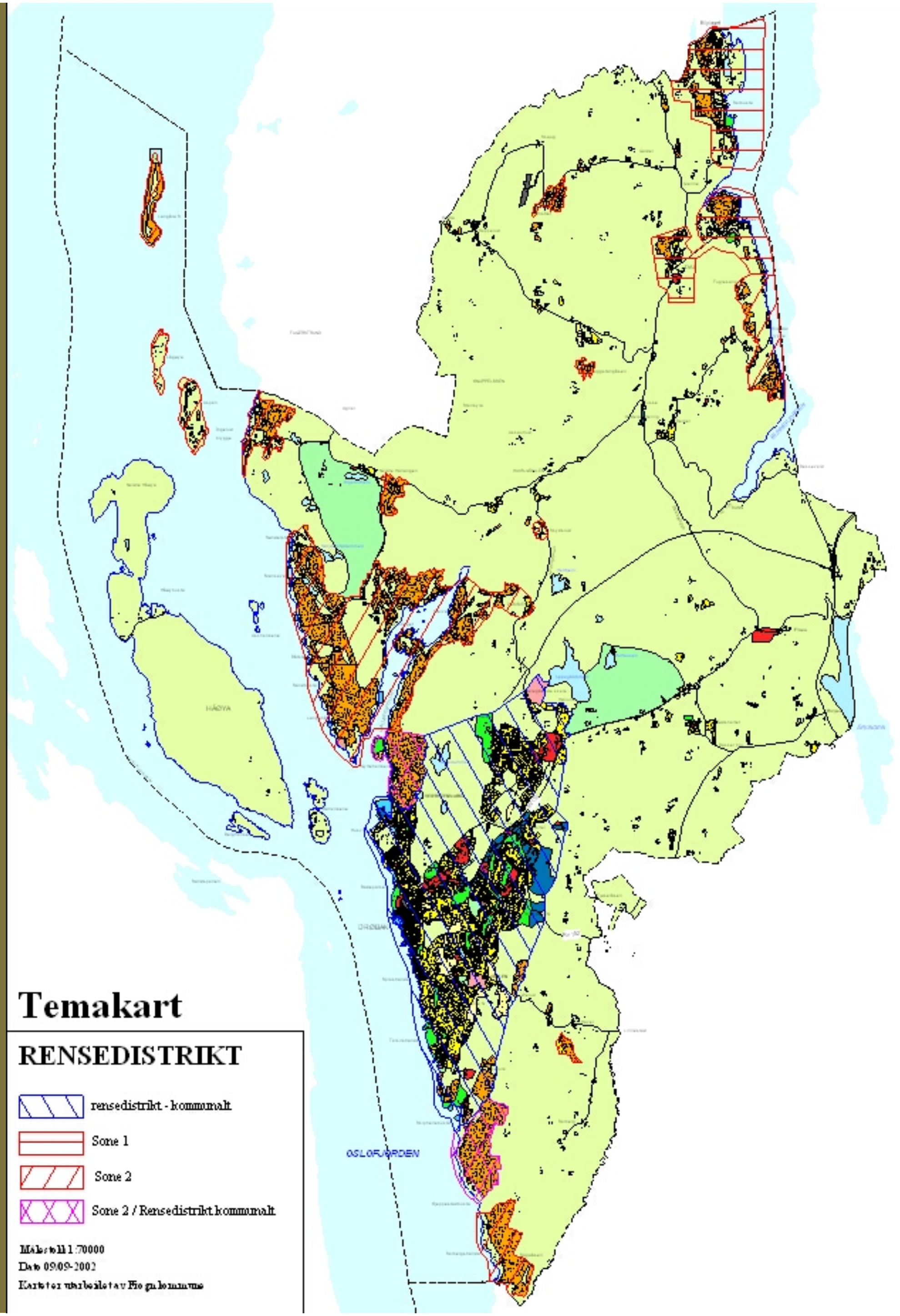
Economic evaluation

- Economic aspects are not well researched
- Comparison with conventional sewage treatment systems is challenging to conduct:
- Benefits from ecosan not always only material, e.g.
  - increased safety
  - better quality of life
  - better health
- Additionally, figures concerning the true cost of conventional sanitation systems are less available.
- Huge investment cost made in the past (piping system) – now no new costs arise

Big ideas and decision making?



The case of Frogn municipality



Norwegian and Local Legislation

- Two different acts
  - Pollution Control Act
  - The Planning and Building Act
- In addition Frogn municipality uses
  - a nation-wide regulation, and
  - a local regulation
    - Site specific plans (detailed, but guidelines only)
    - Easy to use
    - Criteria for the content of
      - Bacteria
      - Phosporous
      - Nitrogen
      - in the treatment plant effluents

Approved Decentralized Sanitation Systems

- The Frogn municipality legislation recognizes three different decentralized systems:
  - Constructed wetlands
  - Mini package treatment plants
  - Source separation - Sewage holding tanks (collection tanks) in combination with ”Compact filter for greywater”

Decision in 2001

- 3 alternatives examined
  - Connecting the area to the existing sewer and water supply system at a total cost of 98 bill. NOK
  - A new (conventional) sewer treament plant in the area with external water supply at a total cost of 64 bill. NOK
  - A system based on decentralized sewer systems and local water supply at a total cost of 50 bill. NOK
- Political decision for decentralized sewer system.


SPECIALISTS IN WATER POLLUTION CONTROL
Klargester
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The Local Administration

- A minimum of government administration
- Sewer plants are privately owned
- Maintenance normally given by manufacturers/builders
- Random and systematic inspection
- Testing the treatment plant effluents
- Use a GIS-based control system
- Financed by application fees (5300 NOK = 650 €)
- A Project manager
  - View and assess sites for treatment plants
  - Act as a consultant/guide
  - Collecting information on builders, planners, and consultants
  - Supply all necessary documents
  - Handle and process applications within 3 weeks
  - Initate plans for new areas

Valuing environmental projects

- Discounting: to understand some basic economic concepts about discounting
- Cost benefit analysis: to become able to read and assess CBA critically
- Other social valuation methods (MCA etc)

Economic Considerations: Costs of Sanitation Systems

Investment costs

- Material
- Work (wages or opportunity costs)
- Financing Costs (interest)
- Technology / licenses / research
- Pre-feasibility study, project design, social work, capacity building
- Amortisation time (to calculate annual cost)

Toilet facility:

- Room
- Toilet pan and seat
- Piping, Water Supply
- Equipment for cleaning
- etc.

Treatment :

- pipe system (?)
- Construction cost: biogas plant, composting facility etc.
- Transport to and from treatment facility
- sewage treatment system (plant, decentralized construction)
- etc.

Operational costs

- Work / opportunity cost
- Operation and maintenance/personnel
- Materials of consumption water, power
- Transport
- Maintenance work, attrition (depreciation)
- Quality control / research / (?)
- Disposal or use of waste / by product
- Environmental cost
- Etc.

Support costs

- Planning and strategy development
- Institution building, information system
- HR-Development
- Monitoring and assessment
- Follow up for training and support
- etc.

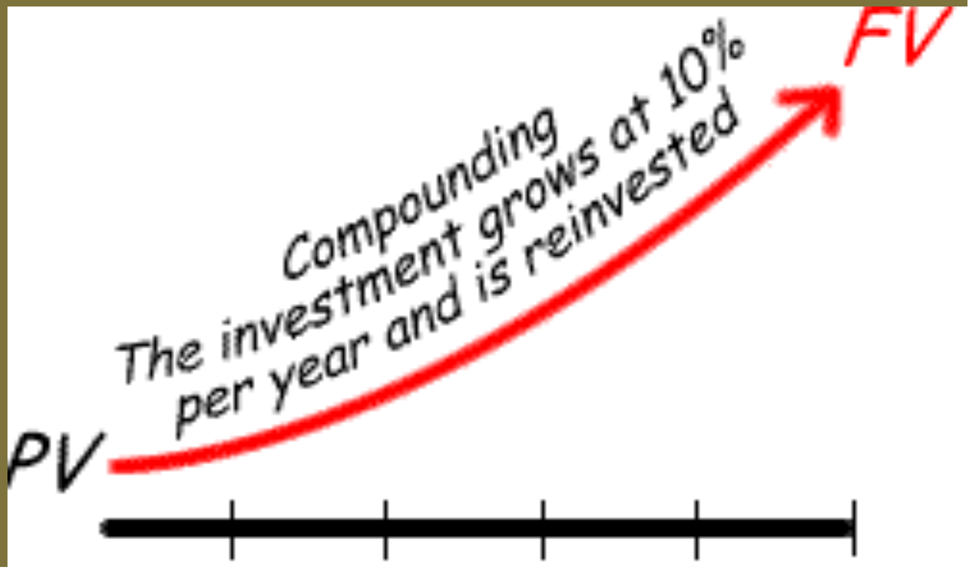
Source: adapted from (1)

Interest rate and the value of time!

- What is an investment
- When the time-lag between costs and income matters!
  - *Interest for investment*
  - Consumption
  - Risk
  - Inflation

Compounding

- You put money in an account today (its present value - **PV**)
- for a promised rate of return (interest - INT)
- for a number of periods (NPER - usually months or years).
- The interest received in reinvested at the end of each period - it compounds.
- The future value (FV) is the value of the investment compounded at the end of a given number of periods.
- We know the value of
  - our initial investment
  - and the interest rate,
  - and can calculate the **FV** at the end of any period.



Future value - Compounding

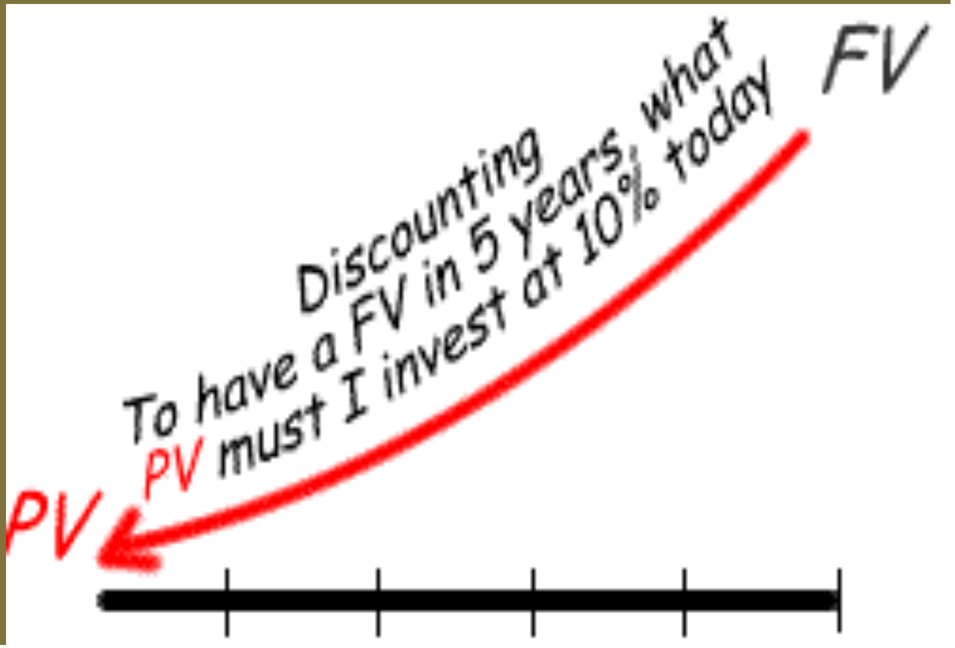
- FV = $ 1 000 x $(1 + 0.08)^3$
  - = $ 1 000 x (1.2597)
  - = $ 1 259.70
- FV = PV (1 + *i*)
- Compounding
- The compounding factor tells us
  - the value of 1$ after *n* years with interest rate *i*
  - n = 4
  - i = 9 %
  - PV = 10
  - **FV = 14.12**

Discounting

- It is the reverse of compounding.
- We know how much we need on a specific date in the future (**FV**)
- and calculate how much we need to invest today (**PV**)
- at an interest rate.
- Work from the future back to the present

You can find Excel functions to make these calculations by searching Excel Help

- FV (compounding) or
- PV (discounting).



Present Value - Discounting

- $PV = \$ 1\,000 \times (1 + 0.08)^{-5}$
  - $= \$ 1\,000 \times (0.68058)$
  - $= \$ 680.58$
- $PV = FV \times (1 + i)^{-n}$
- Discounting
- The discounting factor tells us
  - The present value of a future amount of money
- n = 5
  - i = 9 %
  - FV = 20
  - **PV = 13.00**

Discounting the future and NPV

$$NPV = 10{,}000 + \frac{10{,}000}{1.1} + \frac{10{,}000}{(1.1)^2} + \cdots + \frac{10{,}000}{(1.1)^t}$$

Assuming infinite time horizon,

$$NPV = 10{,}000 + \frac{10{,}000}{1.1} + \frac{10{,}000}{(1.1)^2} + \cdots + \frac{10{,}000}{(1.1)^\infty}$$

$$= 10{,}000 \times \frac{1}{0.10} = 10{,}000 \times 10 = 100{,}000$$

Amortization and Annuity

$$PMT = PV \times \frac{i}{1-(1+i)^{-n}}$$

$$PV = PMT \times \frac{1-(1+i)^{-n}}{i}$$

- Annuity: A term used to describe a series of equal period payments (PMT) (receipts or expenditures)
- Annuity = investment x annuity factor
- Example
  - PMT = 4 178 200 x $A^{-1}_{20/7}$ = 394 393 (amortization)
  - PV = 272 446 x $A_{20/7}$ = 2 886 300

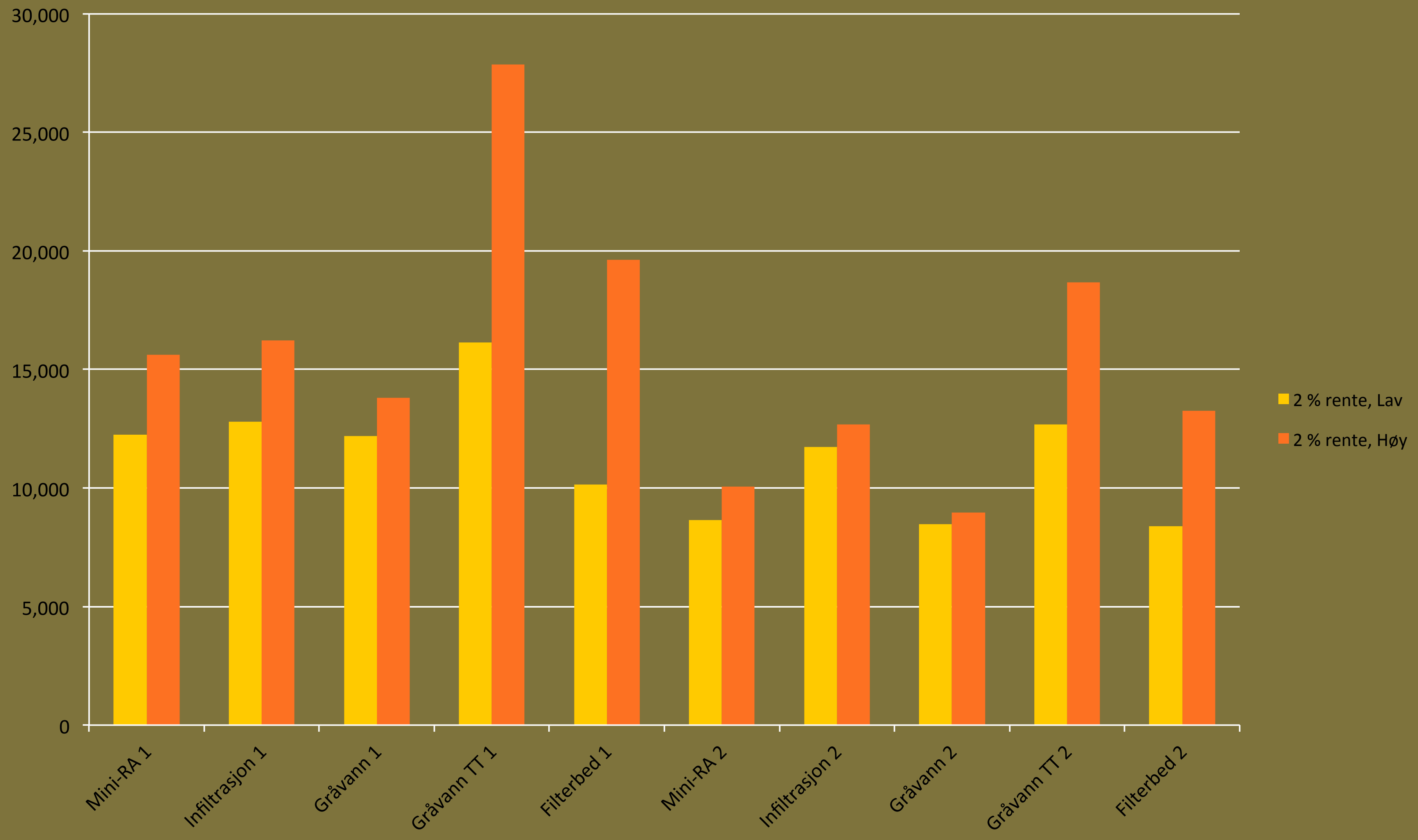
Comparing investments over time – NPV and annuity

- NPV: How does the net present value of the present value of the operational costs + the investment cost compare for two different wastewater systems
- Annuity: The NPV per period
- The higher the interest rate the lower PV of future cash-flows

	Naturebased	Conventional
Investment cost, NOK in total	3 000 000	1 000 000
Operational cost, NOK/year	100 000	300 000
Annual cost, i=7 %	**383 000**	**395 000**
Annual cost, i=0 %	250 000	350 000
lifetime, 20 years		

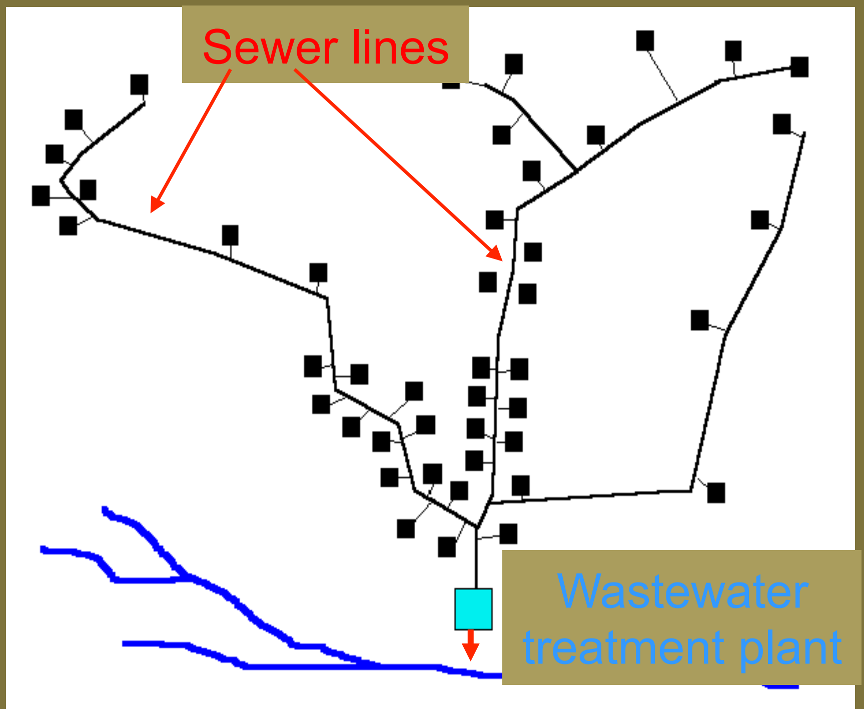
Årskostnader ved 2 % rente for ulike desentrale avløpsanlegg

(fra Hanserud og Refsgaard 2012, tidsskriftet Vann)



++ Conventional Waterborne Sanitation: Investment Cost for Collection

Investment Cost of centralised sewer systems



Initial investment costs for centralised sewage treatment systems make up for the largest part, i.e. 70 to 90% of the total cost of sewage treatment.

- Collection system **70 - 90 %**
- Treatment **10 - 30 %**

(Otis 1996, Mork et al.2000)

Consider lifespan of pipe network!

In the US:

- 37% of all new developments are serviced by onsite or decentralised systems
- over 50% of onsite/cluster systems are in cities and their suburbs

(USEPA 2000)

Costs: Conventional Waterborne Sanitation


Children's Drawings from Rajendranagar, Bangalore

- Difficulty: Setting of the **boundaries** of system often leads to many important external costs or even benefits being overlooked.

- **Conventional waterborne sanitation**
- **In addition to the investment, reinvestment and operation and maintenance costs of the sewer network and plant**:
  + expected health benefits
  – environmental externalities
  – possible pollution of the receiving water
  – loss of a recreational area
  – possible effect on drinking water treatment
  – loss of natural habitats
  – effects on coastal areas
  – effect of medical residues
  – impoverishment of soils as a result of nutrient loss
  – water costs

Source: (17)

Ecological Sanitation Systems: Cost Considerations


Children's Drawings from Rajendranagar, Bangalore

- **Ecosan systems**
- external costs may include:
  - the necessary transformation costs to adapt the existing sanitary infrastructure
  - additional awareness raising activities
  - need for continued research and development of different parts of the system.
- **In contrast to conventional systems: external benefits:**
  - securing the drinking water supply
  - improvement of soil structure and fertility
  - increased access to fertilising agents
  - reduced energy consumption in the treatment works
  - nutrient and resource conservation
  - potential for energy production
- Boundaries for evaluating sanitary systems are significantly expanded, and the tools for appraisal need to be expanded accordingly.

Source: (17)

Why Cost benefit analysis?

- A technique to identify, measure and weigh-up costs and benefits of a project in order to aid government to decide to go ahead or not
- Market failures to achieve social efficiency
  - i.e., no market for environmental goods,
  - no market for future consumption
- Externalities
  - i.e., non-use benefit of environment conservation, social costs of pollution
- Marginal issues
- Meeting social objectives,
  - Like equity, fairness, public good
  - need gov't intervention to achieve social goals by implementing 'projects ⇓

Economic concepts underlying CBA

- CBA is a market test of the social worth of the project.
  - Where markets do not work perfectly
  - What aggregate of individuals want
- In doing so, opportunity costs rather than financial costs are used.
  - Opportunity costs: costs measured in terms of the next best alternatives forgone.
- CBA purports to be a way of deciding what society prefers. CBA informs decision makers as to which option is socially most preferred.

Valuing environmental projects

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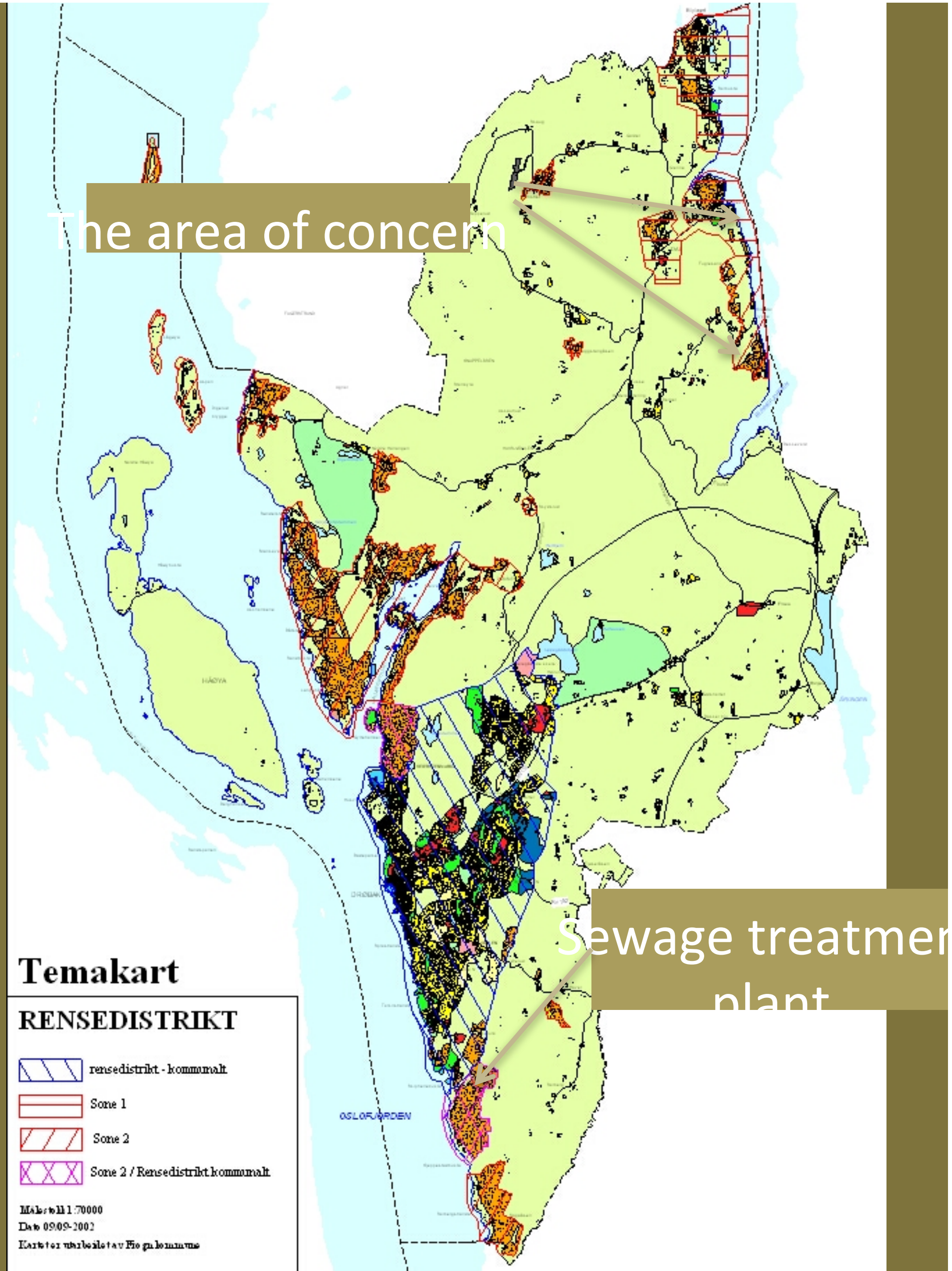
Methods for assessing projects

Aspects	**Methods**		
	Cost-benefit analysis	**Multi-criteria analysis**	**Deliberative institution**
Who	Consumers	Decision makers, (stakeholders, analysts)	Members of society (facilitators)
What	Willingness to pay One-dimensionality	Defining alternatives, criteria, weights etc. Multi-dimensionality	Defining alternatives, arguments Multi-dimensionality
How	Observation	Observation, consultation, participation	Participation

Source: Vatn, 2004

Frogn municipality



EXERCISE
Economy and Environmental effect for the Frogn Case

In order to compare the centralized and decentralized alternatives in economic terms you should calculate, The present value for the whole investment, the total annual cost and the phosphorus removal cost effect for the two alternatives.

406 households

Use an interest rate of 6%, 20 years lifetime and 1.2 g of phosphorus discharge per person per day and the following data:

Investment cost (NOK)	98 000 000	50 000 000
O&M cost (NOK)	960 000	610 000
P-removal %	75	95

If you are interested some information about centralized systems and energy use can be found in (18).

Planning a system for wastewater and water in a rural district

Area description	
406 households, 6 % interest, 20 years lifetime, 1,2 g P/day/person	
Centralised system	
Investment cost	98 mill. NOK
Operational costs	960 000 NOK
Annual costs	23 410 NOK per household
P-treatment efficiency	75 %
Cost-efficiency	20 3740 NOK/kg treated P
Decentralised system	
Investment cost	50 mill. NOK
Operational costs	610 000 NOK
Annual cost	12 240 NOK per household
P-treatment efficiency	95 %
Cost-efficiency	8 410 NOK/kg treated P

Conclusions

- Whether a shift from System A to System B is a ‘good idea’ in whatever context implies that we must pay close attention to
  - the treatment of social and economic costs and benefits in decision-making
    - Hardware alone is not sufficient!
  - the nature of the interests involved
  - the role and performance of human institutions
  - the ownership and control of relevant assets, resources and systems.

What can we do?

- Highlight the differences between Systems and the benefits to different groups and submit to public view and discussion
- Reveal (name and shame!) the embedded interests involved in preventing change
- Strengthen the information, knowledge and debates by good research in different contexts
- Relevant education and practices!
- Act personally and locally! Don’t wait for international agreements or politicians (Brox, 2008)

References

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