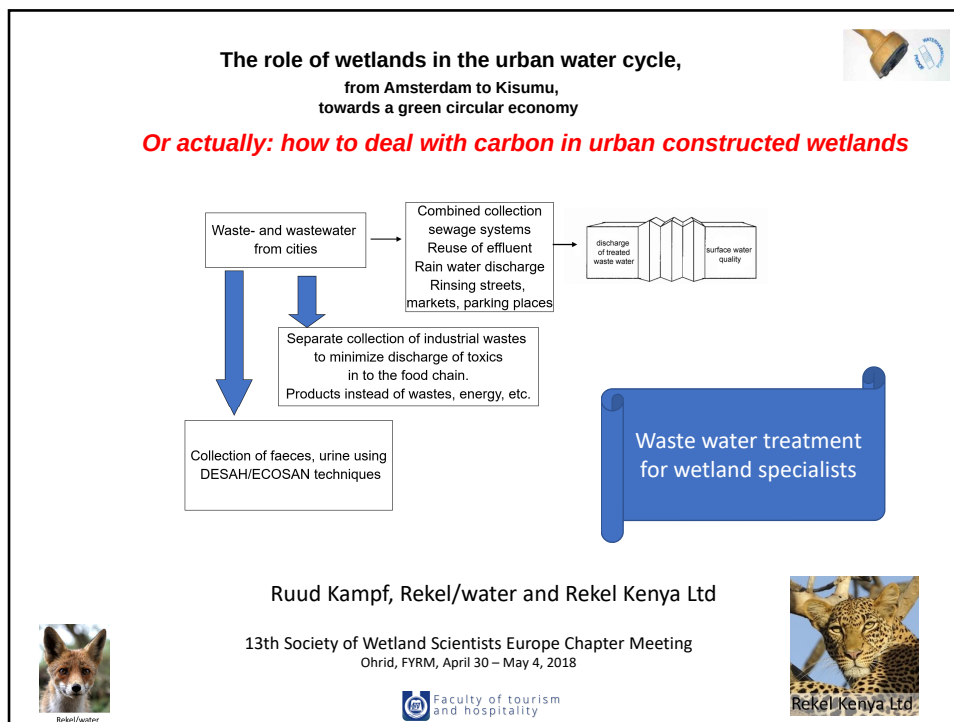




**Workshop**  
*Nature based methods  
 for reuse of treated water*

*incl. food chain approach for removal of nutrients*

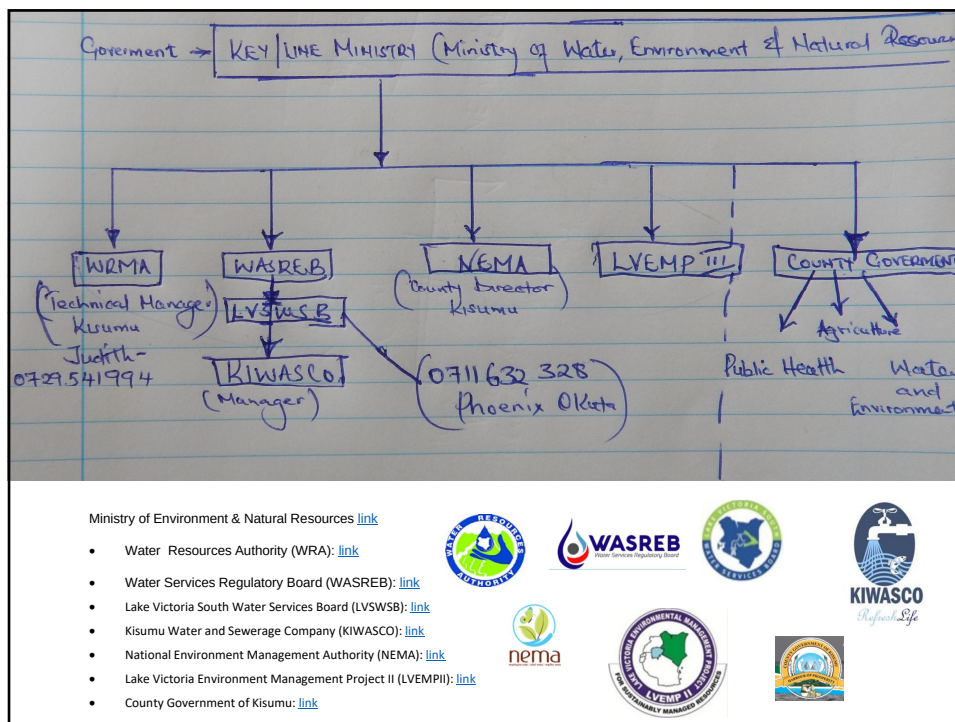
Ruud Kampf  
 Schermerhorn  
 The Netherlands

For KIWASCO - Kisumu Water and Sewerage Company  
 On behalf of VEI, Dutch Water Operators

Kisumu, Kenya, Monday 18th of December 2017

KIWASCO  
 Refuse Life

VEI  
 Dutch Water Operators



## Kisumu

- city: 600,000 inhabitants
- metropolitan region, incl. satellite towns over 1 million
- third largest city in Kenya



Map 1.1 Kisumu town and informal settlements at Lake Victoria in Western Kenya



<https://en.wikipedia.org/wiki/Kisumu> and Bard, 2011: <http://publications.lib.chalmers.se/records/fulltext/223308/223308.pdf>  
<https://www.businessdailyafrica.com/news/counties/Kisumu-plans-Sh800m-sewage-treatment-plant/4003142-4381354-ityuc8/index.html>



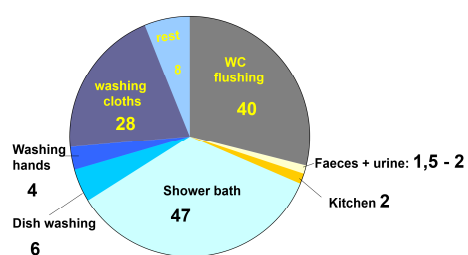
## Conclusions

- It is not just bringing in wetlands in cities
  - Sponge cities, climate resilient, etc.
- Know the limitations of constructed wetlands
  - Not for thick wastes, blocking, etc.
  - Do technical what can be done technical
    - Separate collection, new sanitation
    - Settling of waste, digesters for gas-production
    - High-loaded activated sludge plants
- Know the advantages of constructed wetlands
  - Low loadings bring values

[www.waterharmonica.nl](http://www.waterharmonica.nl)

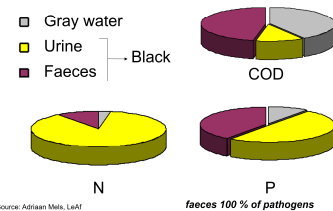


## Amsterdam: How much waste water per person?



Total 136 l/day

### COD, N and P in separate flows



In 1.5 – 2 l/day:

- Carbon (COD): 60 %
- Nitrogen (N): 90 %
- Phosphorus (P): 80 % ?

and

- Pathogens: 80 – 100 %
- Medicines: 90 – 100 %

NB: waste water volume in developing countries varies

## Constructed wetlands can block...



Shimo la Tewa prison, Mombasa, Kenya

waste water to thick because of “poor flush”

### Separate collections of human wastes will:

- reduce the nutrient loads with 60 – 90 %?
- make nutrients available for re-use

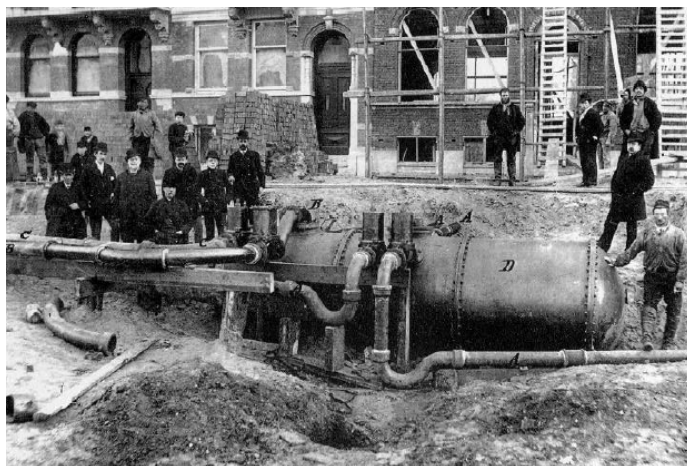


## Separate collection is not new



The Boldoot car: Honey buckets in Amsterdam

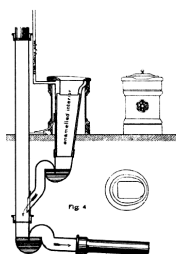
## The vacuum sewage system of Charles T. Liernur (1828 - 1893)



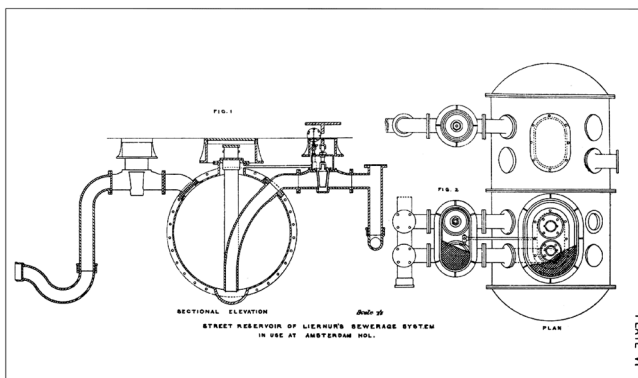
With thanks to Adriaan Mels (LeAF, Wageningen UR), based on Thesis Van Zon, 1986

## Liernur collection of black wastes for reuse in agriculture

- Underground iron sewer
- Vacuum transport of faeces and urine



iron toilets





## Practical use of Liernur system in:

- Leiden 1200 people; 1870-1915
- Dordrecht 800 people; 1872-1887
- Amsterdam 1700 people; 1872-1912
- St. Petersburg 22.000 people

Prague 10.000 soldiers

## Liernur: profitable production !!

- manure or “poudrette”
- ammonium sulphate

In Amsterdam profitable from 1897 - 1915 !!

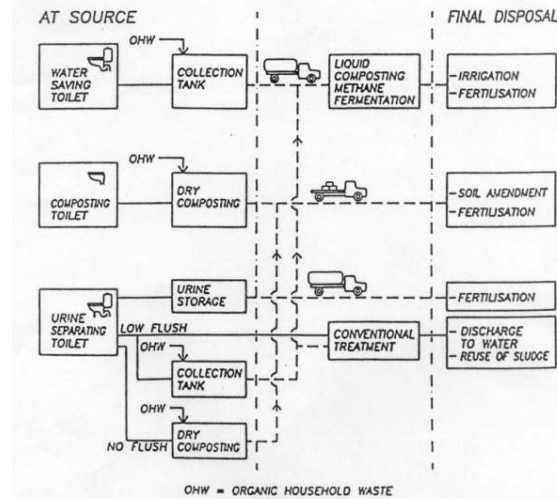
Disappeared:

Waterclosets

Ahead of time?

## Logistics in urban black water and organic waste flows

Logistics are a problem??



Vråle, 1999

## How much is 1.5 – 2 liter per day?

Four 200 l containers:

- blue ... = paper (1x/month)
- green . = compostable material (2x/month)
- orange = plastic (1x/month)
- black ....= 'other' wastes (1x/month)



It takes over  
100 days to.....



Underground storage in (semi)-urban areas

## More treatment of waste water or also separate black waste collection?

|                                          |          |                     |
|------------------------------------------|----------|---------------------|
| black wastes, per p.e.                   | 2- 5     | l/day               |
| number of p.e not connected, not treated |          |                     |
| volume of black waste                    |          | m <sup>3</sup> /day |
| amount                                   | 120 -350 | trucks per day      |
| trucks n (per day)                       | 10 - 40  |                     |

City of Kisumu will need only 10 – 40 trucks to transport black wastes



## Amsterdam: “New sanitation”

Waternet: new sanitation at various locations in Amsterdam with modern vacuum toilets

- This is a new (old....) way to collect and process waste water.
- We separate the dirty water from households at the source:

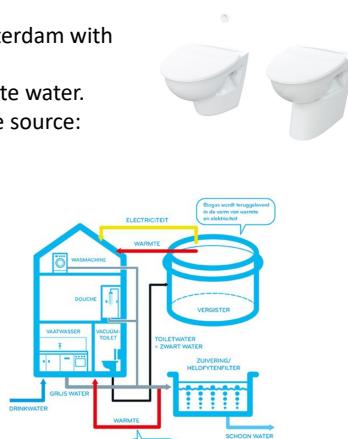
2 streams: black and gray

This is a chance for Kisumu to be an example in Africa

More information on New sanitation in The Netherlands:  
 ....in Dutch

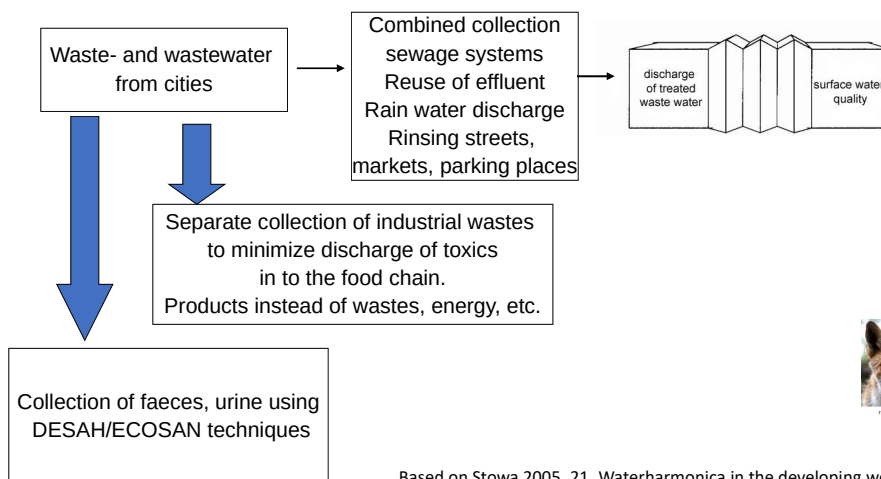


<http://www.saniwijzer.nl/>



[www.waternet.nl/werkzaamheden/nieuwe-sanitatie/](http://www.waternet.nl/werkzaamheden/nieuwe-sanitatie/)

## Waterharmonica plus separate sanitation plus clever sewage management



Based on Stowa 2005\_21\_Waterharmonica in the developing world  
[http://www.stowa.nl/publicaties/publicaties/waterharmonica\\_in\\_the\\_developing\\_world](http://www.stowa.nl/publicaties/publicaties/waterharmonica_in_the_developing_world)

Kisumu is one of the few Eastern African cities with:

- A good drinking water delivery?: 35,000 m<sup>3</sup>/day
- Safe drinking water delivery to 70 % of the people
- Sewerage system inadequate
- Sewage treatment plants: 12,000 m<sup>3</sup>/day

Waste water treatment  
 for only 30 % of the  
 population!

Sewage Treatment Plant Kisat:  
 An old, but well operated trickling filter plant

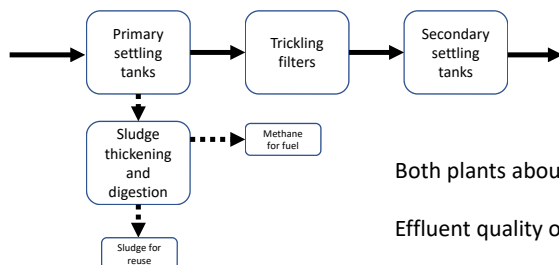


Nyalende:  
 A well operated oxidation ponds system





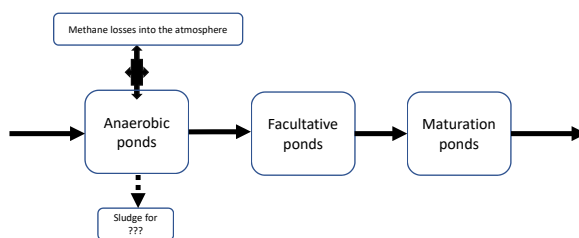
### Kisumu STP Kisat: conventional with trickling filters



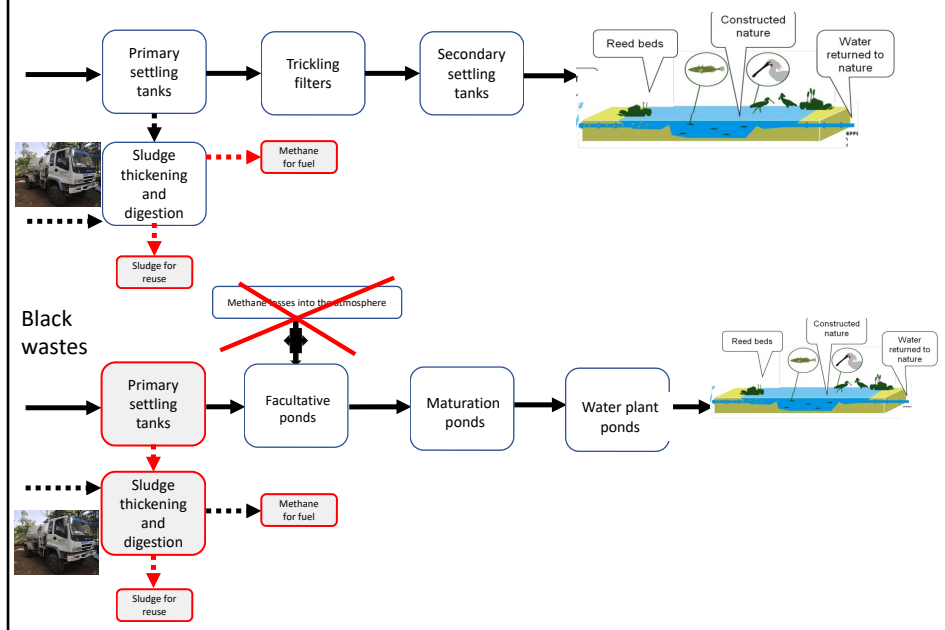
Both plants about 6000 m<sup>3</sup> water per day

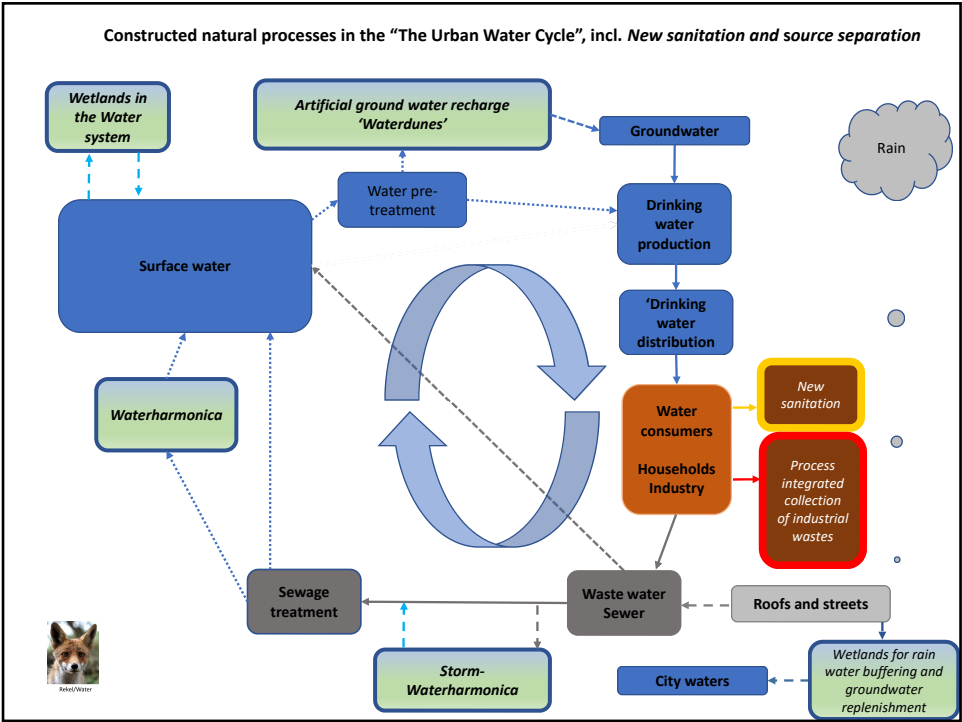
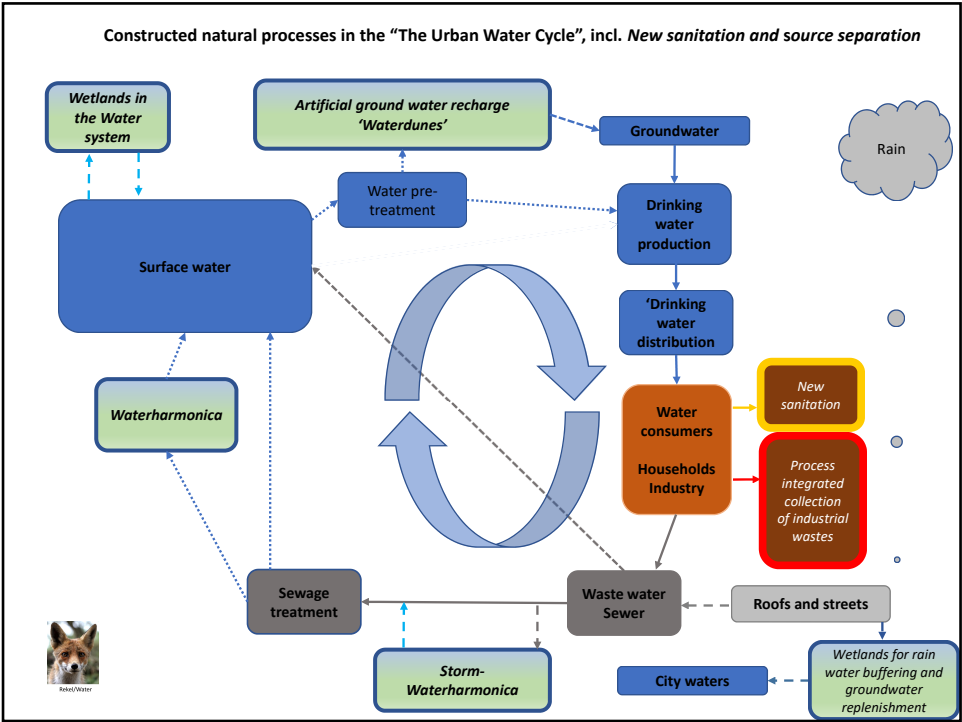
Effluent quality of Nyalenda ponds is much better than K

### Kisumu Nyalenda: oxidation ponds



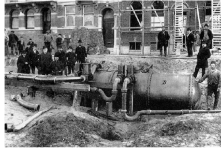
### Combination of processes in Kisat and Nyalenda (simplified process schemes)





## Source separation in the urban infrastructure

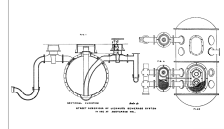
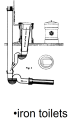
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Disappeared:

- Ahead of time?
- Introduction of water closets

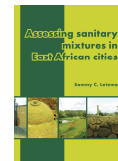
A jump of over a century: is Kisumu going to make this jump too??



Moving from a linear to a circular economy means minimising the waste and pollution by reducing, recycling and reusing. The City of Amsterdam aims to redesign twenty product- or material chains. The implementation of material reuse strategies has the potential to create a value of €85 million per year within the construction sector and €150 million per year with more efficient organic residual streams. Amsterdam set up an innovation program on the circular economy; [www.amsterdamsmartcity.com/circularamsterdam](http://www.amsterdamsmartcity.com/circularamsterdam). Share your innovative concepts and ideas on circular economy here.



<https://amsterdamsmartcity.com/themes/circular-city>



## The message

- It is not just bringing in wetlands in cities
- Know the limitations of constructed wetlands
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**BUSINESS DAILY**

ABOUT 7 million Euro

COUNTIES

**Kisumu plans Sh800m sewage treatment plant**

TUESDAY, APRIL 10, 2018 21:21





Kisumu County plans to construct a Sh800 million sewage treatment plant as it seeks to improve water and sanitation services.

The Treasury has secured Sh22.29 billion (€180 million) deal in concessional loans and a grant with three European agencies for water and sewerage projects in Mombasa and Kisumu.

Treasury secretary Henry Rotich Thursday announced the agreements with French Development Agency (AFD), which will provide €140m (Sh17.3bn), European Investment Bank €35m (Sh4.3bn) and a €5m (Sh619m) grant from the 28-nation European Union.

**KISUMU WATER AND SEWER**





Rekel/water



Thank you  
Ruud Kampf





Rekel/kenya Ltd

Ruud Kampf, Rekel/Water and Rekel Kenya Ltd

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