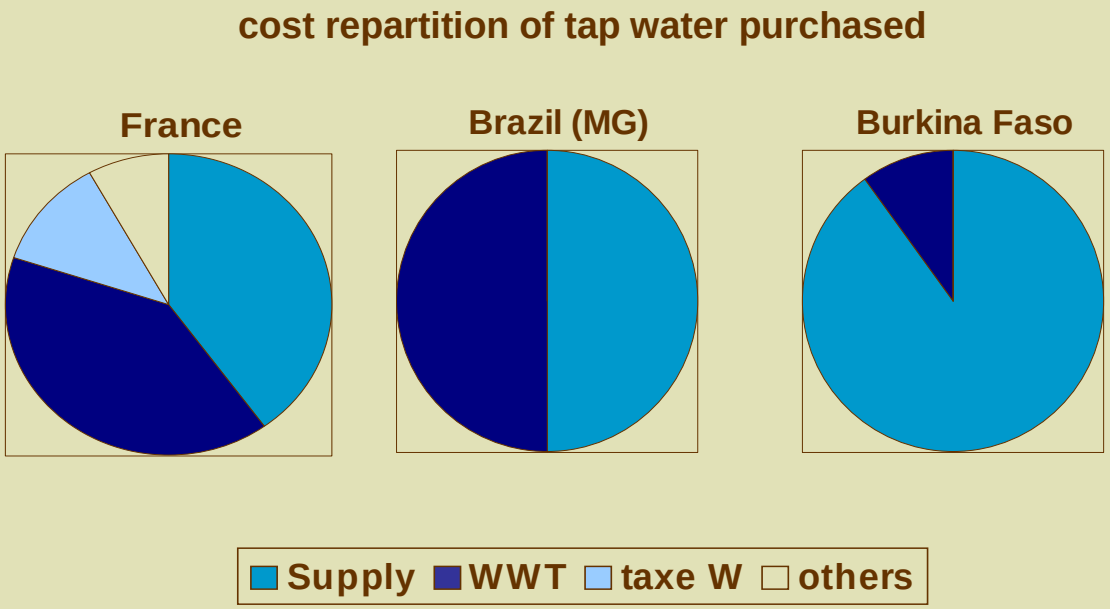
Waste water as a resource for sustainable sanitation in West Africa : An example of integrated treatment

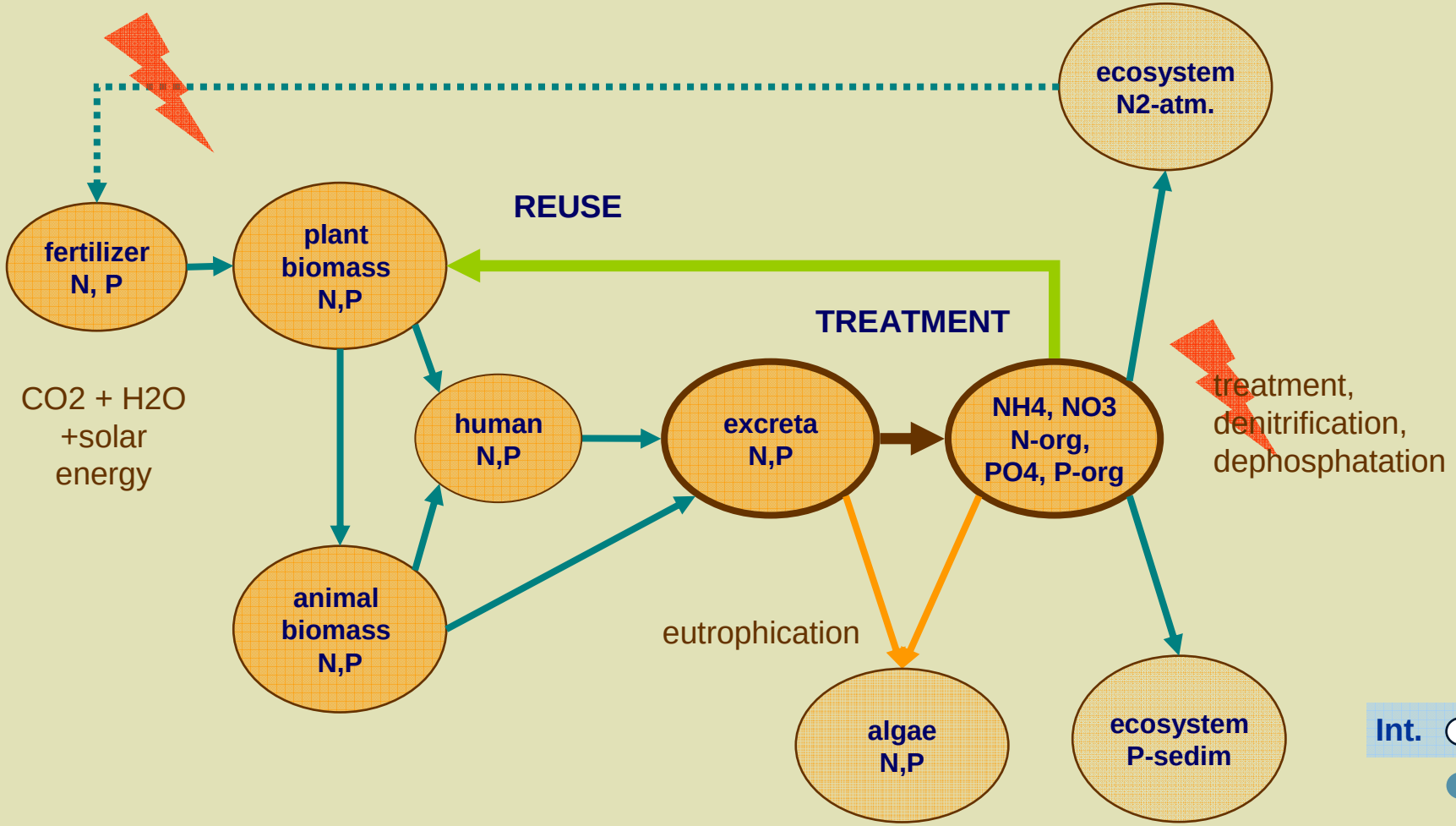
Martin SEIDL
University Paris-Est, Cereve ENPC, UMR-MA102, France
(martin.seidl@cereve.enpc.fr)

Sani LAOUALI & Tahar IDDER
University Abdou Moumouni Faculté des Sciences, Niamey Niger

1. INTRODUCTION
scope of the problem : financing WWT

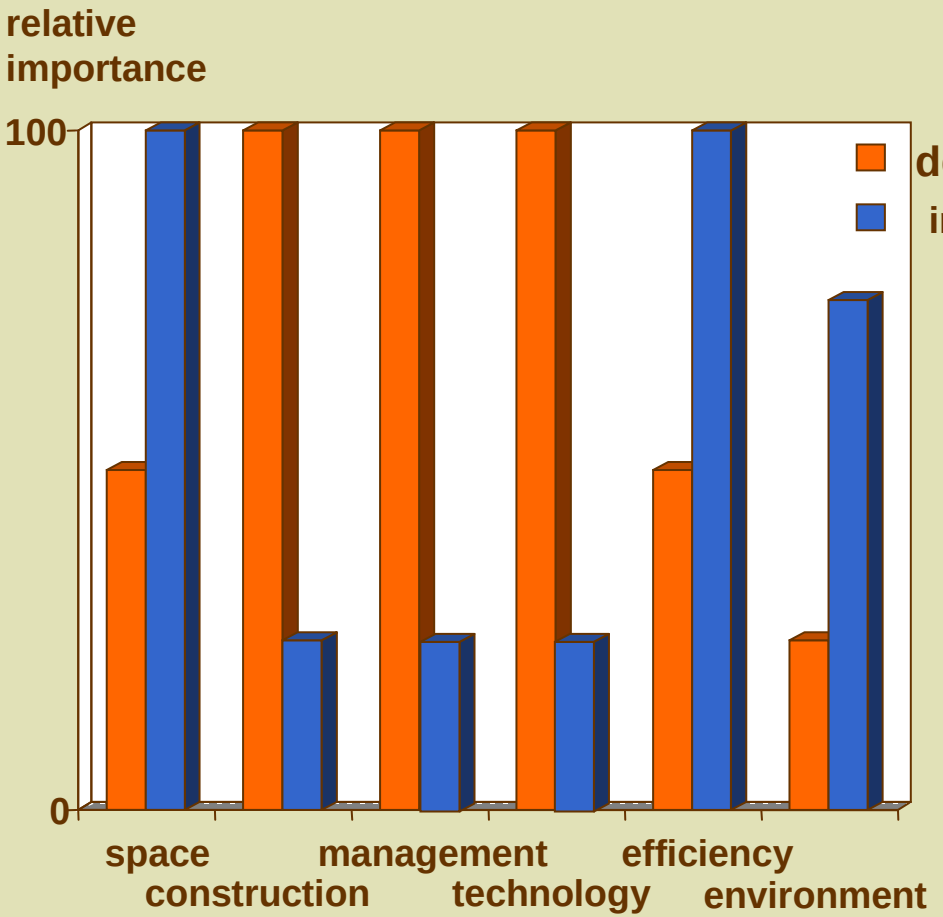


1. INTRODUCTION
scope of the problem : energy



Int.

1. INTRODUCTION
scope of the problem : developing countries

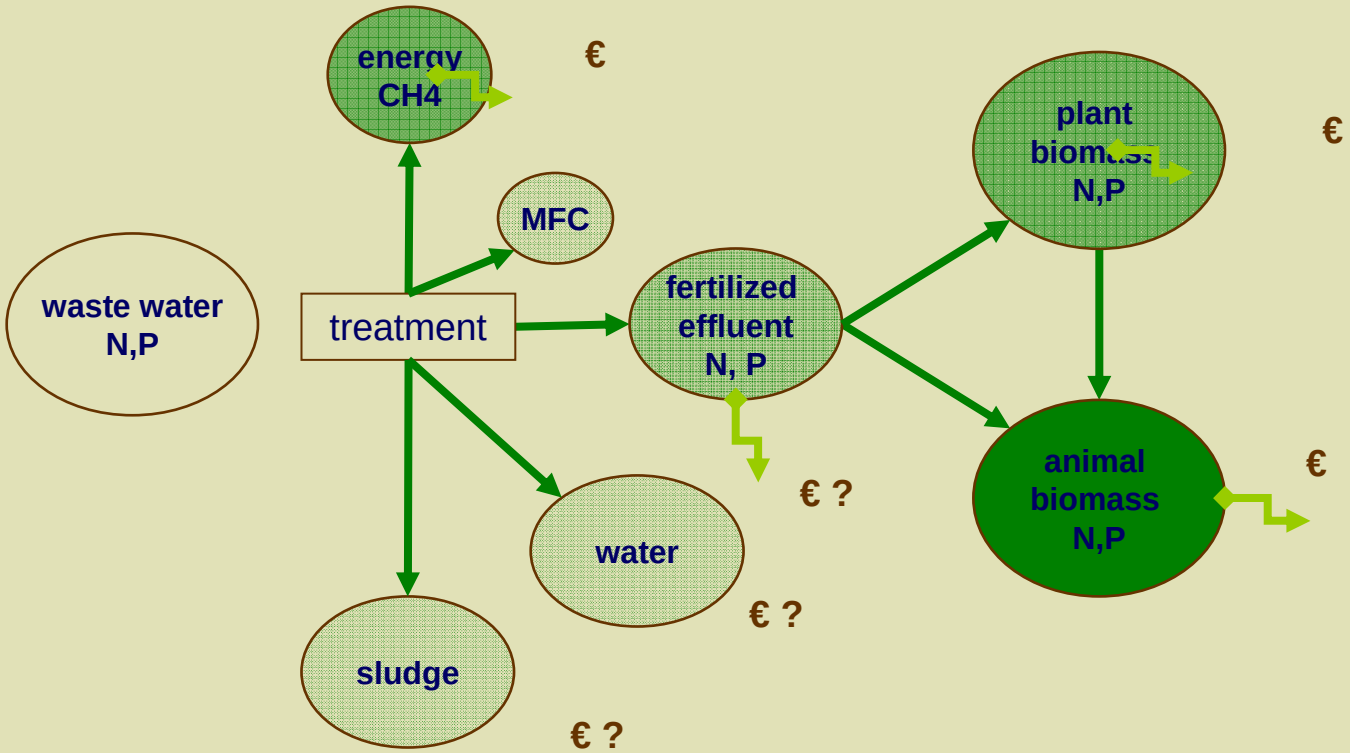


The choice of wastewater treatment, is dependent of the socio-economic status of the society. The priority is rarely the same

- stabilization ponds
- overland flow
- filters
- UASB
- others

Int.

1. INTRODUCTION
scope of the problem : financing



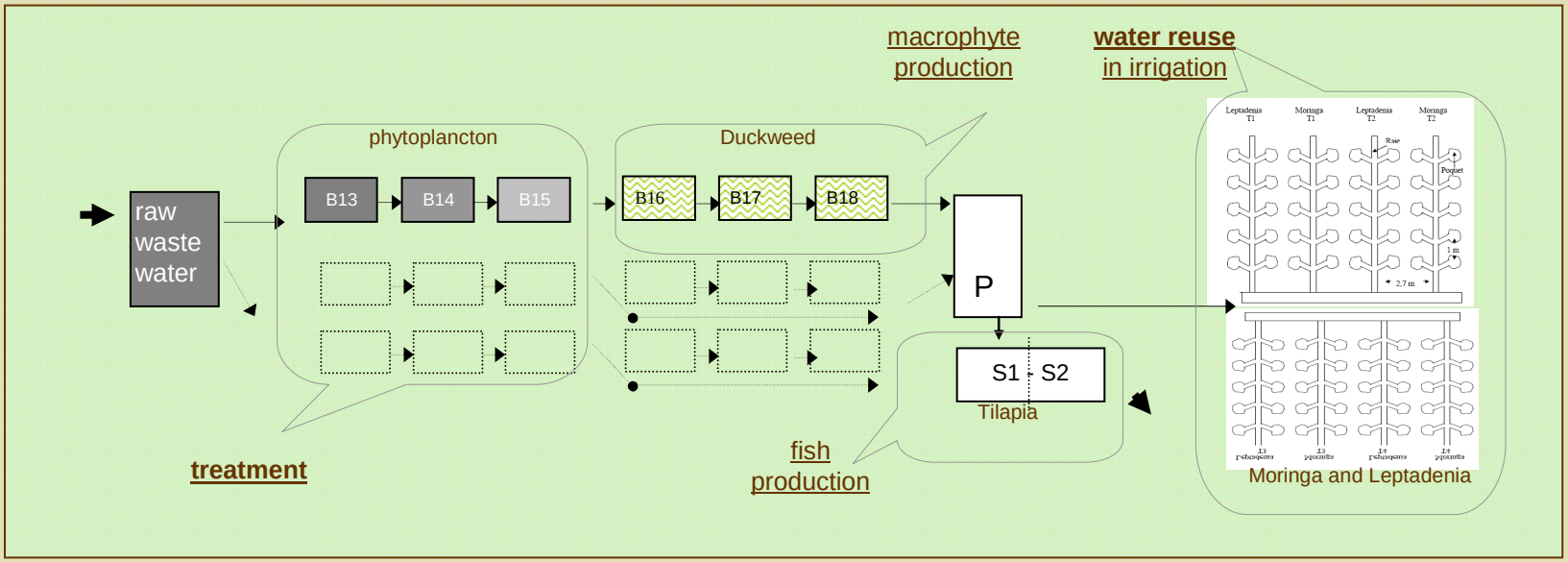
Int.

2. MATERIAL & METHOD
setup

The pilot station of the University Abou Moumuni in Niamey (**Niger**) was constructed 8 years ago to study the different possibilities of wastewater treatment with stabilization ponds and the possibilities of reuse of the byproducts in urban agriculture

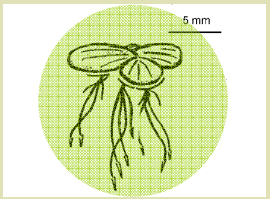
2. MATERIAL & METHOD
setup

- **treatment <5m²/e.h.**
- **maximum Lemna surface**
- **WHO quality effluent for irrigation**



capacity	residence time	BOD5 load anaerobic pond		Lemna s. crop	Tilapia t0	Letadenia Moringa
e.h.	days	kg /d	kg /ha/d	kg/ha	Nr./ha	Nr./ha
50	**15**	**1.1**	**780**	**2300**	**50 000**	**7400**

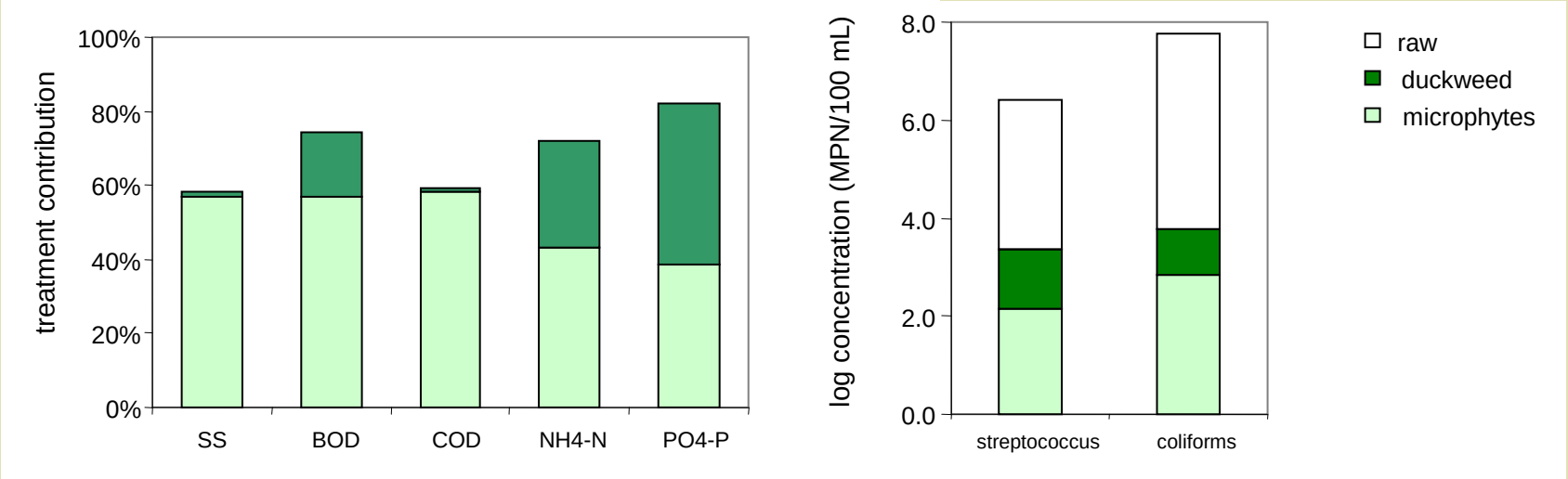
2. MATERIAL & METHOD
data collection



water	macrophytes Lemna spp.	fish Tilapia nilotica	plants Laptadenia hastata & Moringa oleifera
Q, pH, t, pO2 S.S., S.V.S. COD, BOD5 NH4, NO3,Nkj, Ptot Coliforms Helminths	wet weight dry weight composition N & P	number length weight	high tree diameter number of leafs dry weight of leafs

3. RESULTS treatment



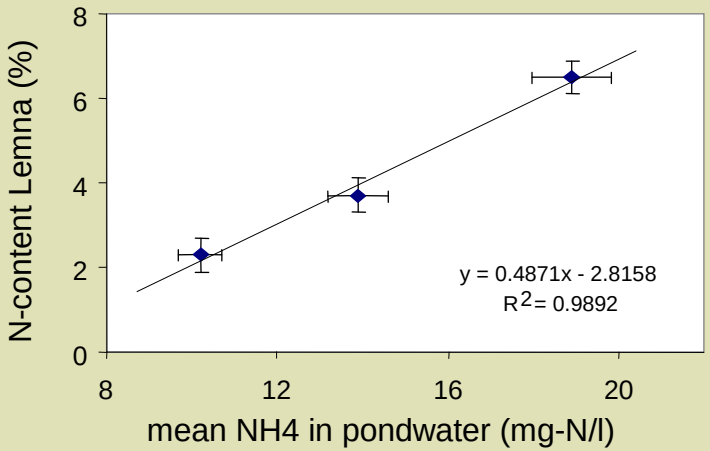
Parameters	SS	BOD-f	NH4-tot	PO4	pathogenes	
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	strepto	coli
Entry	238	312	45.7	3.91	2.5E+06	5.7E+07
Outflow	99.6	43.6	12.8	0.70	1.1E+03	9.8E+03
Efficiency	64%	74%	69%	80%		>99.95%

3. RESULTS treatment

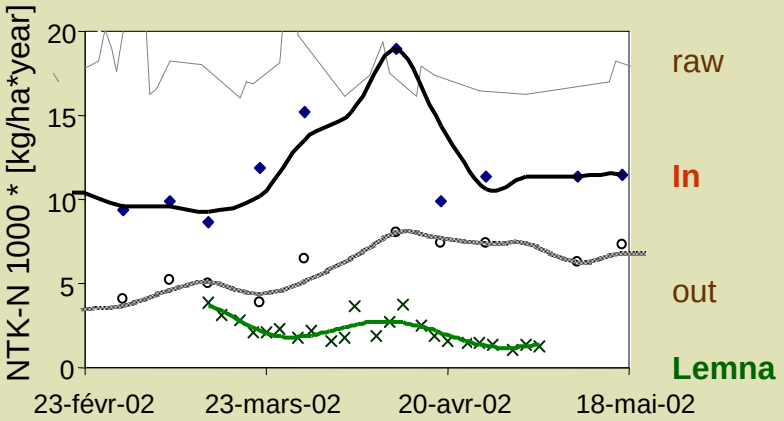
Type WWTP	Country	Total surface		Treatment capacity	Flow	Resid. time	BOD entry	BOD efficiency
		m²	E.H.	m²/E.H.	m3/j	days	mg/l	%
LAGOONS natural	Burkina Faso	1256	200	6,3	22	36	698	66%
LAGOONS macrophytes	Benin	ca. 50	50-150	1-3	2,5	17		60%
LAGOONS integrated	Niger	85	25	3,4	3,3	16	312	68%

Use of macrophytes in WWT system may improve the treatment process. However its importance should be seen rather in its economic potential than in its treatment ability.

3. RESULTS
Lemna

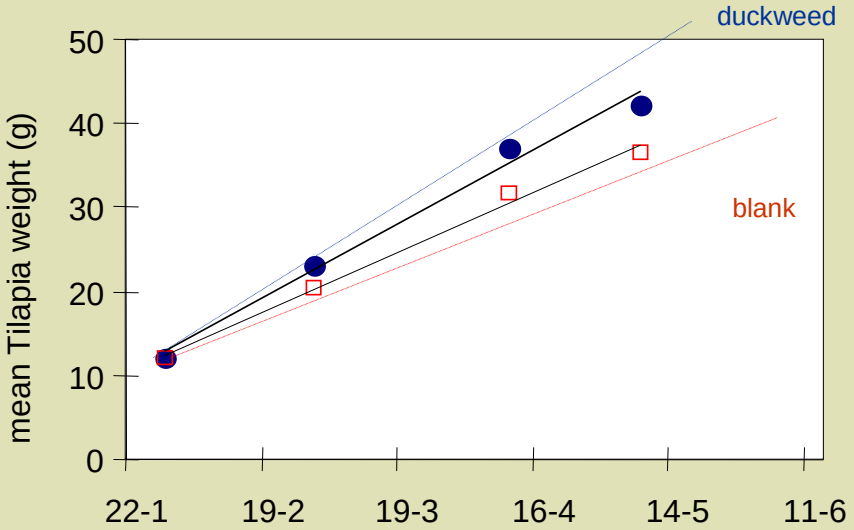


The N content of the Duckweed showed positive correlation with the ammonia content of the pond water. **An increase of 10 ppm of NH4-N of the treated water gave an increase of 5% of the dry weight N content in the harvested duckweed**



The macrophytes play an important role in the nutrient elimination like nitrogen and phosphorus. About **20% of dissolved nitrogen** entering the system of macrophytes has been immobilized and extracted

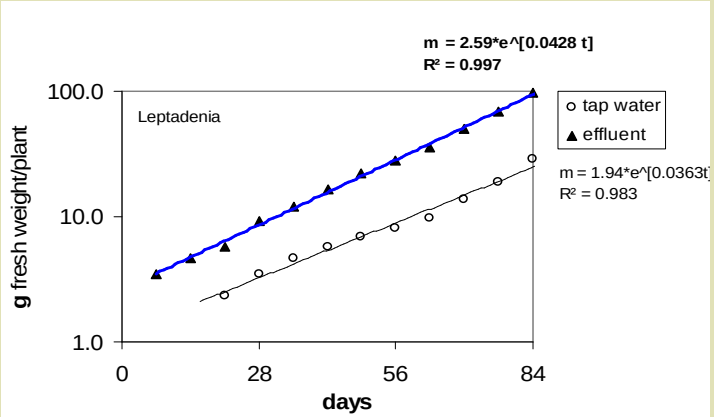
3. RESULTS
Tilapia

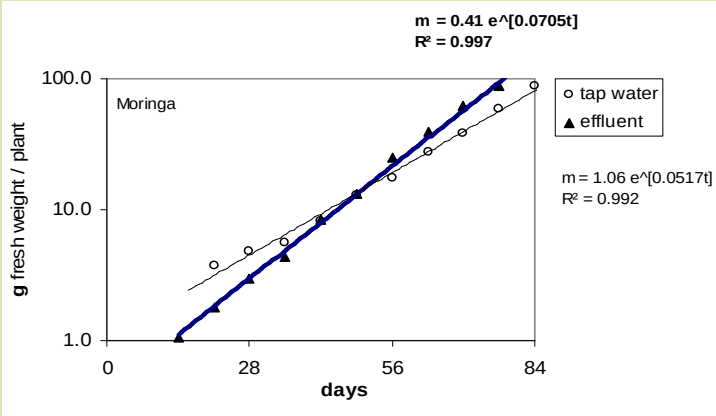



Tilapia

The duckweed production of 700 kg/ha/d of fresh weight has made it possible to produce about **475 kg/ha/month of Tilapia**. Grow of Tilapia in basin fed with fresh duckweed (S2) was about 20%.higher than Tilapia (S1) grown in the same effluent without supplementary feeding (blank).

3. RESULTS
Leptadenia & Moringa





Application of treated effluent significatively increase the productivity of both species tested in the irrigated culture.

This productivity can even be slightly higher using compost, showing that the effluent, depending the specie, may not contain all the nutrients in sufficient quantity. **The increase is the highest for Leptadenia.**

Though quite different in morphology the productivity of Leptadenia and Moringa grown with effluent is quite similar about 70 000 kg/ha/year.

3. RESULTS
Productivity analysis

TABLE Growth and productivities of the used species. The prices indicate market price observed on the markets in Niamey during the wet season in 2005.

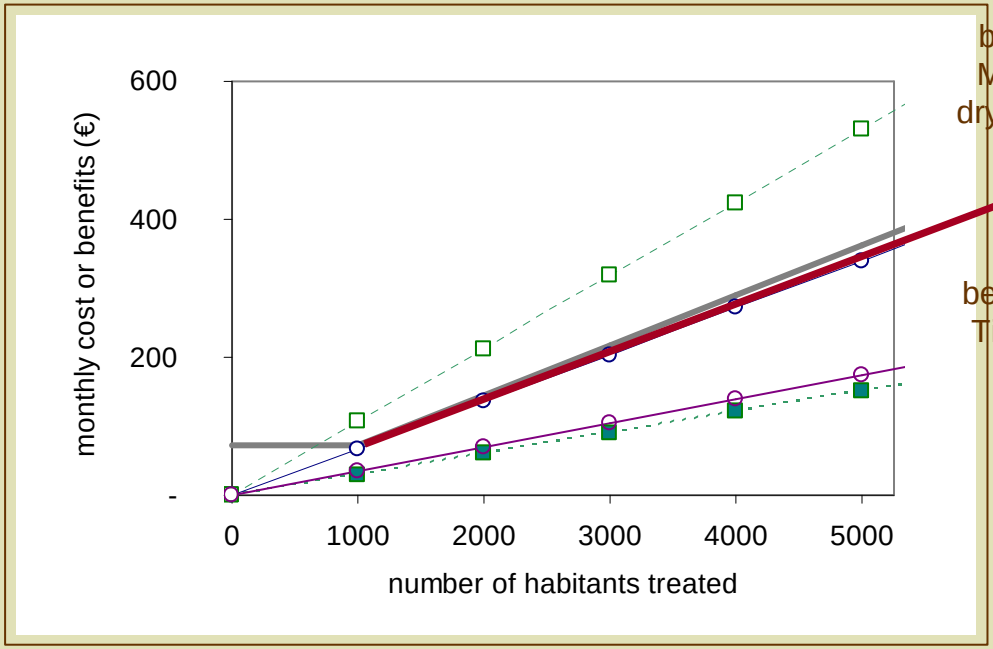
	gain	fresh weight (g/leaf)	K (g/day/id.)	g_dry/ g_wet	n	fresh leaf production kg/ha/year	price rain season CFA/kg
Moringa=0	**+40.7%**	120	0.0517	16.4%	36	49 900	60
Moringa =effl		120	0.0705	16.3%	37	70 200	60
Lepta=0	**+232%**	3369	0.0363	17.2%	56	20 800	20
Lepta=effl		3368	0.0428	17.1%	63	69 000	20
Lemna	**(+12%)**	0.5	n.d.	5.6%	3	326 000	20?
Tilapia=effl	**+23.3%**		0.26		68	4300	1000
Tilapia=lemna			0.32		72	5600	1000

3. RESULTS
Economic analysis

price dry season =
2.5*
price wet season

<u>maintenance costs</u>
(€/1000 eq. / month)

pumping eq.	21 €
electricity	21 €
labour	30 €



inhab	water consumption l/pers	treatment surface m²/eq	surface AGRI	costs	Moringa sales mean	Tilapia/ Lemna sales mean
5000	60	5	10%	363 €	234 €	200 €
id.	id.	id.	20%	363 €	469 €	401 €

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4. CONCLUSIONS -1

Our results show the feasibility of the wastewater treatment in a system of urban agriculture. The stabilisation ponds used, attains removal efficiencies for BOD and COD comparable to other systems in the region, but with significantly better pathogen removal. Only 3.4 m^2 were needed to treat an equivalent of habitant. The effluent meets the WHO guidelines for reuse in agriculture.

The duckweed used play an important role in the elimination of nitrogen and phosphorus. About 20% of the dissolved nitrogen entering the duckweed system was immobilised and extracted with the harvest. For an optimal duckweed production care should be taken to maintain the temperature and the ammonium below 30 mg-N/l and 30℃.

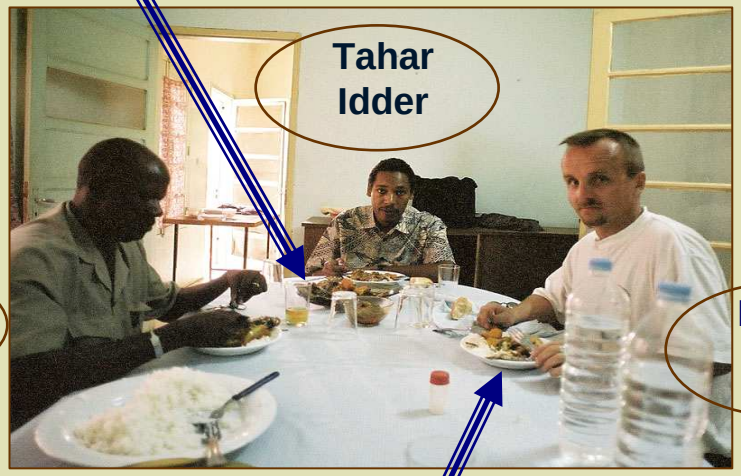
4. CONCLUSIONS -2

The combination of fish farming (Tilapia) and irrigated cultures (Moringa; Leptadenia), make the system more economically stable, as the gross revenue from Moringa during the dry season can be as twice as high as from Tilapia. The culture of Moringa or Leptadenia can be used also as post-treatment to produce an highly polished effluent.

The study showed that a treatment system combined with Duckweed /Tilapia or Moringa farming can generate **sufficient gross revenue to cover the maintenance and operating costs** of the WWTP facility. Once the treatment facilities set up, the maintenance can be financed by means of urban agriculture. Such agro-sanitary systems can form a solid base for sustainable wastewater treatment in West Africa.

The authors thank you for your attention

Tilapia nilotica



Tahar Idder

Sani Laouali

Martin Seidl

Moringa olifeira

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