Internationale Konferenz zum Thema
„Diffuse Einträge in das Grundwasser: Monitoring – Modellierung – Management"
Landwirtschaft und Wasserwirtschaft im Fokus zu erwartender Herausforderungen
29.-31. Januar 2007 in Graz, Österreich

International Conference on
„Diffuse Inputs into the groundwater: Monitoring – Modelling – Management
Agriculture and Water management in the light of future challenges
January 29 to 31, 2007 in Graz, Austria

Nachhaltiges Nährstoff-Management und seine Auswirkungen auf den Schutz des Grundwassers und der Oberflächengewässer dargestellt am Donaueinzugsgebiet (DEZ) und Schwarzem Meer

Sustainable Nutrient Management and its Impact on the Protection of Groundwater and Surface waters in the Danube River Basin (DRB) and Black Sea

[daNUbs EVK1-CT-2000-00051/ http://danubs.tuwien.ac.at]

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Sustainable Nutrient Management and its impact on the Protection of Groundwater and Surface water in the Danube River Basin (DRB) and Black Sea

A) Overall view / Synopsis

A) **This overall view / Synopsis**

B) **The nutrient system and its participants**

C) **Environmental goods of protection:** Environmental problems in different environmental spheres mainly caused by the nutrients C, N, P, S

D) **Protection aims:** Qualifications for nutrient levels and loads both in surface waters and groundwater

E) **Scenarios daNUbs (Overview)**

F) **Detailed nutrient managements**
- F 1) Best available techniques (BAT) diffuse sources, esp. Agriculture
- F 2) Healthy Human Nutrition (food consumption) and need oriented food production
- F 3) Policy management system: (Inter-)national legislation

G) **Impacts Scenarios daNUbs**

H) **Driving and preventing forces for the implementation / development of a sustainable nutrition system i.e. in Germany**

I) **Summary**

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B) The nutrition system and its pariticipants

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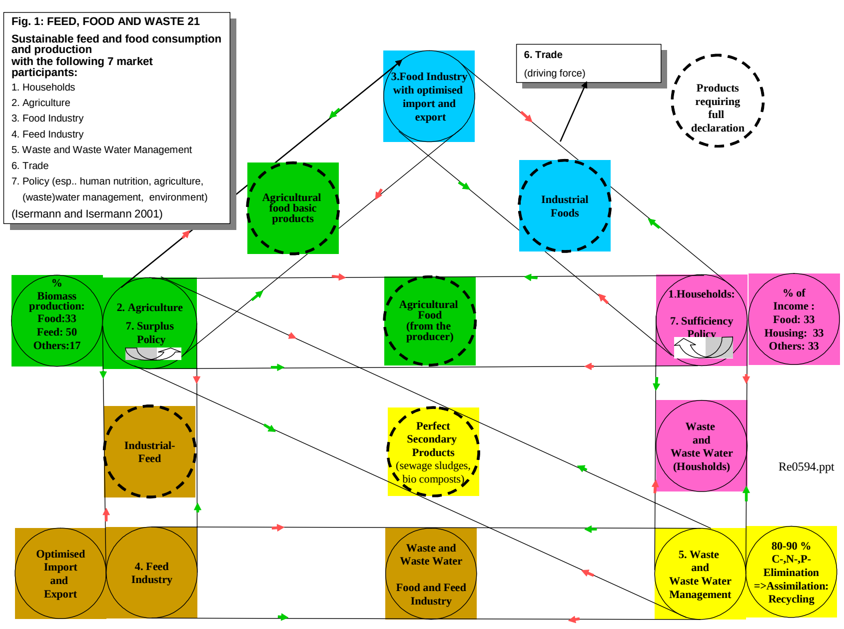

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Tab. 3: Sustainable resp. Clean(er) production and use of biomass products
[according to WCED 1987)(Brundtland Report); Smit and Smithers 1994; Xunlong and Smit (1994)]
(less important: (X); important: X;)

Biomass	Production			Use		
		Agriculture				
Spheres	Providing services (industries)	Plant production (Plant nutrition)	Animal production (Animal nutrition)	Processing transport, storage, sales preparation	Consumption	Waste(water)-management => recovery => recycling
Products :						
1. Food	(X)	X	X (also Fishery)	Human nutrition		=> nutrients, energy
2. Feeds	X	X	X (also Fishery)	Animal nutrition		=> nutrients, energy
3. Raw materials (like fibre etc.)	--	X (also Forestry)	X	X	X	=> nutrients, energy
4. Bio-Energy	(X)	X (also Forestry)	--	X	X	=> nutrients
Demands to sustainability: clean(er) production and use of biomass products	A) Generally: development that meets **the needs** (and not the "demands" not tolerable higher than the needs; => affluence, surplus) of the present without compromising the ability of the future generations to meet those of the future => **need oriented production and use** B) Especially: To produce and use biomass over the long term in such a way that simultaneously: a) the natural resource base is not damaged (ecological component), => **Consistency** b) that the **basic needs** of the producers (existence of economic returns which are sufficient to adequately reward producers (economic component) => **Efficiency** c) and that the **basic needs** of the consumers can be met (social component => **Sufficiency** => **(Re-)Integration of the ecological, economic and social components of a sustainable economy and life style**					

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Renaming

of former Bureau of Sustainable Agriculture (BSA)
to the
Bureau of Sustainable Nutrition, Land Use and Culture (BSNLC)

The Bureau of Sustainable Agriculture (BSA) founded on January 01, 1994 was renamed on January 01, 2007 to the Bureau of Sustainable Nutrition, Land Use and Culture (BSNLC). The leadership of Mrs. Dipl.-Ing.agr. Renate Isermann and the activities of Dr. Klaus Isermann within BSNLC will remain the same.

Reasons, contents and aims

According to the Agenda 21 of Rio (1992) a sustainable development within individual parts (i.e. here agriculture) of a system (i.e. here the nutrition system) cannot exist. Instead it is essential keep in account the sustainable development of the **entire system of nutrition** with its integrated counterparts.

This total system of nutrition consists of different parts like agriculture with plant nutrition and animal nutrition, human nutrition as well as waste and waste water management depending on corresponding land use and culture. Within this nutrition system the actors are fertilizer and feed industry, agriculture and afforestation of land, food industry as producers, households as consumers, waste and waste water management as destructors as well as trade and politics as transformators.

According to its aims, the bureau BSNLC still views itself as mediator between science and politics to implement both economically (efficiency), ecologically (consistency), socially (sufficiency) and ethically the sustainable development of nutrition especially in respect to the balances of nutrients and energy.

Since 1994, BSA has published more than 160 publications considering sustainable nutrition.

Dipl.-Ing.agr. Renate Isermann Dr. Klaus Isermann

C) Environmental goods of protection

Fig. 2:
Interactions of boundary crossing continental and global environmental damages caused by reactive components of the multifunctional (!) nutrients C, N, S and monofunctional P anthropogenically produced by the sectors:
1.Nutrition: Agriculture with Plant and Animal nutrition,
Human nutrition, Waste and Wastewater management
2.Power Economy (inclusive traffic)
3.Industry and Bussines (Isermann 1991,2003)

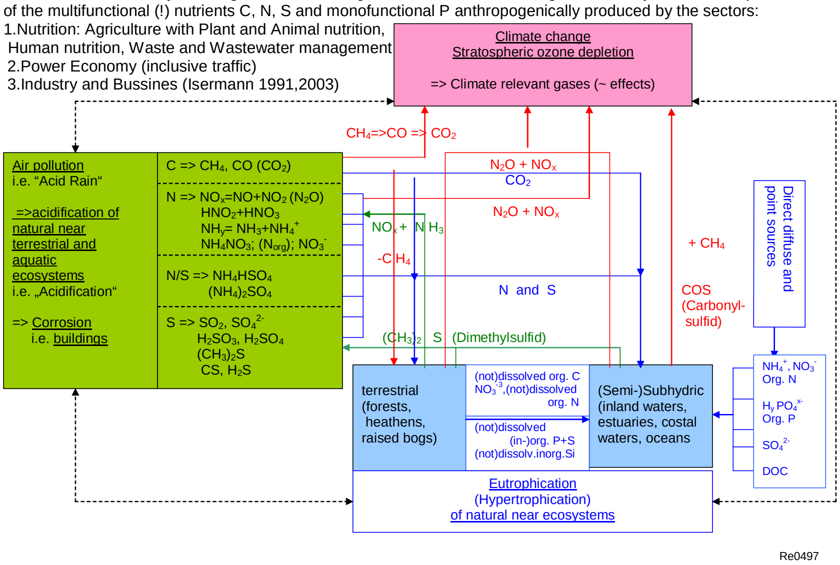

Fig. 3: Warmer seas bring algal bloom explosion (23 August 2006)

Toxic algal blooms are flourishing across Europe's coastal waters, fuelled by this summer's hot weather and fertilized by human-induced pollution - a phenomenon that is likely to become a common sight in a warmer Europe, the European Environment Agency has warned.

Algae blooms in coastal waters pose an increasing health risk

While algae form an essential part of the marine eco-system as a nutrient for zooplankton, and populations usually increase in the summer months, the EEA said this season's blooms were "excessive" and warned against health effects on holidaymakers.

Algae feed off nitrogen and phosphorous in sea water, and thrive when concentrations of these chemicals rise in water polluted by agricultural run-off, fish farming or wastewater.

Phosphorous, present in a number of common household products such as detergents and soap, and finds its way into the sea through wastewater. Some species, such as blue-green algae popular in Scandinavia, extract their nitrogen from the air and only need water high in phosphorous for their populations to explode.

The last three decades have seen rising amounts of algal blooms worldwide as concentrations of both chemicals in coastal waters increased. Rising seawater temperatures are now acting as a catalyst and further stimulating the blooms.

Global seawater temperatures increased by around 0.6 degrees C since the late nineteenth century, according to an EEA report. In Europe, the Mediterranean, Baltic and North seas have warmed by about 0.5 degrees C over the last 15 years.

Other effects on ecosystems include the recent explosion in jellyfish populations that hit European coastal waters at the peak of the holiday season (see related story) and rising populations of other warm-temperate species.

Ingesting algae-infested water can cause poisoning, manifesting itself through nausea, bowel or intestine problems and fever. Although adults are only at serious risk if they swallow substantial amounts of sea water polluted by toxic algae, the EEA warned holidaymakers to take particular care with small children.

Goska Romanowicz

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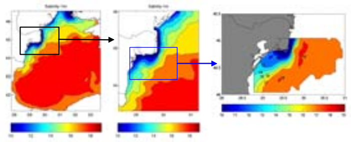

Figure 1: Model to data comparison (averaged over the cruise period of 6-10 September 2002). Left: model surface salinity for the western Black Sea. Middle: same, but zoomed in the data survey area. Right: the data survey surface salinity.

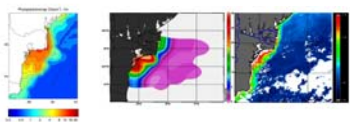

Figure 2: Model to data comparison (averaged over the cruise period of 6-10 September 2002). Left: model chlorophyll-a on the data survey area. Middle: data survey chlorophyll-a. Right: chlorophyll-a from satellite data.

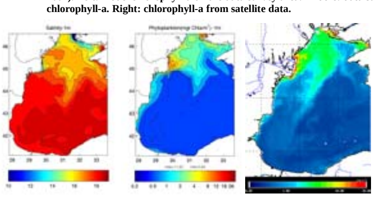

Figure 3: Model to data comparison (averaged over 8-12 July 2003). Left: model surface salinity for the western Black Sea. Middle: same, but for chlorophyll. Right: SEAWIFS chlorophyll. Re0660

Fig 4: Eutrophication / Salinity Western Black Sea

D) Protection aims

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Tab. 5:Qualification of surface waters (? Groundwater/Draft EU-Groundwater Directive 2006) in respect to the nutrient levels C, N, P, S in Germany (LAWA / UBA 2006) (basis value: 90-percentile)

[http:// www. umweltbundesamt.de/wasser/themen/ow_s3_3.htm]

Nutrients	Unit	Chemical water quality categories regarding the nutrient levels, irrespectively of their loads						
		I	I-II	II[1]	II-III	III	III-IV	IV
		Anthropogenic Levels						
		Not influenced Geogenic background dark-blue	very low ½ aim light-blue	moderate aim green	obvious up to 2x aim light-green	increased up to 4x aim yellow	high up to 8x aim orange	very high up > 8x aim red
1. TOC	$mg \cdot l^{-1}$	<= 2	<=3	**<= 5**	<= 10	<= 20	<= 40	> 40
2. total N(TN)	$mg \cdot l^{-1}$	<=1	<= 1,5	**<= 3**	<= 6	<= 12	<= 24	>24
…of it:								
2.1 Nitrate-N	$mg \cdot l^{-1}$	<= 1	<= 1,5	**<= 2,5[2] (drinking water:<11,3)**	<= 5	<= 10 (drinking water:<11,3)	<= 20	>20
2.2 Nitrite-N	$mg \cdot l^{-1}$	<= 0,01	<= 0,05	**<= 0,1**	<= 0,2	<= 0,4	<= 0,8	>0,8
2.3 Ammonium-N	$mg \cdot l^{-1}$	<= 0,04	<= 0,1	**<= 0,3**	<= 0,6	<= 1,2	<= 2,4	> 2,4
3. Total- P (TP)	$mg \cdot l^{-1}$	<= 0,05	<= 0,08	**<= 0,15**	<= 0,3	<= 0,6	<= 1,2	> 1,2
…of it: Ortho-Phosphate-P	$mg \cdot l^{-1}$	<= 0,02	<= 0,04	**<= 0,1**	<= 0,2	<= 0,4	<= 0,8	> 0,8
4. Sulfate	$mg \cdot l^{-1}$	<= 25	<= 50	**<= 100**	<= 200 (drinking water: = 240)	<= 400	<= 800	> 800

[1] Demand up to 2010: strict observance on all measuring locations of LAWA

[2] **Maximum tolerable for total life of adults (70 kg life weight, 2 l drinking water $\cdot$ d^{-1}): 2,9 mg NO_3-N $\cdot$ l^{-1}**

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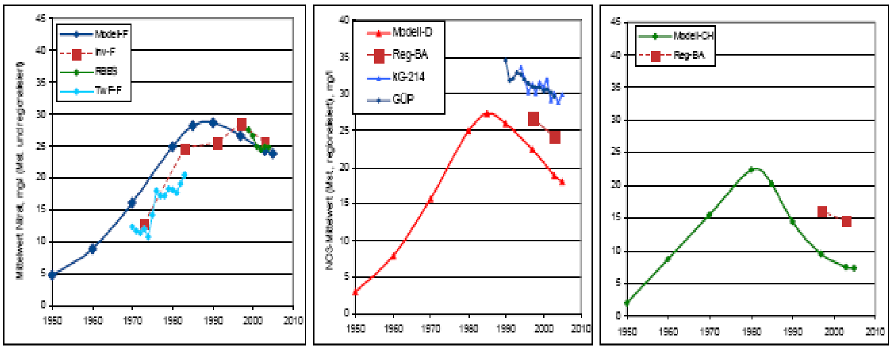

Vergleich Rechnung -Messung für Mittelwerte (F/D/CH)
Comparaison calcul – mesure pour les moyennes (F/D/CH)

re0743

Fig. 5: Nitrate levels in the groundwater of the upper Rhine River Basin (Strele-Grimm 2006)

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Tab. 8: Nitrate and human health

[T.M. Addiscott [1] and N. Benjamin (2004): Soil Use and Management 20, 98-104]

Abstract

1. Nitrate is widely and mistakenly perceived to threaten human health by causing methaemoglobinaemia in infants and stomach cancer in adults, but it does cause environmental problems

1.1 **Methaemoglobinaemia** is a side-effect of gastroenteritis and is not caused by nitrate but by nitric oxide, which is produced I a defensive reaction stimulated by gastroenteritis. The latter may be caused by a bacterium or a virus. The association of methaemoglobinaemia with nitrate may have arisen because early cases of the condition were often associated with wells polluted with bacteria, and the same pollution increased the nitrate concentration.

1.2 Four epidemiological studies sought a link between **stomach cancer** and nitrate but did not find one. The incidence of this cancer has also declined during the last 30 years, while nitrate concentrations in water have increased.

2. Nitrate preserves, rather than threatens, health

2.1 It is reduced by microbes on the tongue to nitrite, which generates nitric oxide when acidified in an antibacterial defence mechanism vital to our well-being. This mechanism **acts with great effectiveness in the stomach against *Salmonella, Escherichia coli* and other organism that cause gastroenteri-tis**.

2.2 It also **acts in our mouths against dental caries and even on our skin against fungal pathogens such as *Tinea pedis* (athlete´s foot).** This mechanism is the basis of the centuries-old practice of adding nitrate or nitric to stored meat to protect against botulism, caused by the most lethal toxin know to mankind.

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‣Total publication see Annex re0610

Tab. 9: Causes of Cancer and their shares:

- 63% of all cancers are caused by an unhealthy life style
- only 4% by inheritance
- and 0% by nitrate and nitrite

[European Prospective Investigation into Cancer and Nutrition (EPIC-Study 1992-2004)]

Causes of cancer	Shares (%)
1. (Over-)Nutrition	**30**
2. Smoking	**30**
3. Infections	**15**
4. Other factors (like medicine, radiation, immune-suppression, hormones, reproduction-factors)	**13**
5. Professional exposition	**5**
6. Inheritance	**4**
7. Alcohol	**3**
8. Nitrate and nitrite i.e. drinking water or added stored meat [1)]	**0**

Re0642

[1)] Addiscott and Benjamin (2004): Annex I of D 3.3

Tab. 10: EC Groundwater Directive (Strasbourg, June 13, 2006)

1/2

European Parliament legislative resolution on the Council common position for adopting a directive of the European Parliament and of the Council on the protection of groundwater against pollution
[12062/1005 – C6- 005/2006 – 2003/0210(COD)]
➔ Important amendments of the European Parliament to the Council common position, especially in respect to nitrate (NO_3^-):

1. **The text voted on by Parliament leaves EU countries free to define threshold values for pollutants in groundwater except for pesticides and nitrates used in agriculture**. However, it does seek to harmonise the methods used to measure to pollutants.

2. **For nitrates, residue levels are limited at 50 mg per litre**, according to the next wording. “The protection of groundwater may in some areas require a change in farming or forestry practices, which could entail a loss of income,” for farmers the text reads. To make up for potential losses, MEPs suggested providing farmers with aid under the reformed common agriculture policy (CAP)

3. **Amendment 4 [Recital 1b (new)]:** (1b) Groundwater must be protected in such a way that good quality drinking water can be achieved by simple purification, as specified in the objectives set out in Article 7(1) and (3) of directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy.
   ➔ Residue levels are limited at 50 mg nitrate (11.3 mg NO_3-N) per litre in spite of nitrate preserves, rather than threatens human health by causing methaemoglobinaemia in infants and stomach cancer in adults
   [Addiscott, T.M. and N. Benjamin (2004): Nitrate and human health. Soil use and management 20, 98-104].

But:

4. **Amendment 3 Recital 1a (new) (1a):** Groundwater is the most sensitive and the largest body of freshwater in the European Union and in particular also the primary source of public drinking water supplies. **The level of protection against new discharges, emissions and losses must be at least comparable to that for surface water of good chemical status.** Pollution or deterioration frequently gives rise to irreversible damage.
   ➔ LAWA-Quality classification for running waters: Residue levels (class II): 3 mg total N/l and ca. 2.5 mg NO_3^-N/l = 11 mg NO_3/l Note: The actual “baseline concentrations” i.e. German main streams are “only” between

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ca. 2-7 mg Total N/l and 1,8-6,3 mg NO_3^--N/l. An only 50% reduction leads to 1.0-3.5 mg Total N/l and 0,6-3,1 mg NO_3^--N/l !

➔ Amendment 3 replaces Amendment 4

1. **Amendment 44, Article 1, paragraph 2, subparagraph 1a (new): This Directive shall not prevent individual Member States from maintaining or introducing stricter protection measures**

2. **Amendment 15, Article 3, paragraph 1, subparagraph 1a (new): The Groundwater quality standards and threshold values applicable to good chemical status shall be based on the human and ecotoxicological criteria underpinning the definition of pollution in Article 2(33) of Directive 2000/60/EC – WFD**

3. Amendment 12, Article 2, point 4a (new): “deterioration” means any slight, anthropogenically induced and persistent increase in concentrations of pollutants in relation to the status quo in groundwater.

4. Amendment 13, Article 2, point 4b (new): 4b “background concentration” means the concentration of a substance in a groundwater body corresponding to no, or only very minor, anthropogenic alterations to undisturbed conditions.

5. Amendment 14, Article 2, point 4c (new): (4c) “baseline concentration” of a substance in a groundwater body means the average concentration measured during the reference years 2007 and 2008 on the basis of the monitoring programmes established under Article 8 of Directive 2000&60/EC. – WFD

10. Amendment 2, Recital 1 (1) Groundwater is a valuable natural resource and as such must be protected from deterioration and chemical pollution. This is particularly important for groundwater-dependent ecosystems and for the use of groundwater in water supply for human consumption

11. Amendment 6, Recital 6a (new): (6a) The protection of groundwater may in some areas require a change in farming or Forestry practises, which could be addressed when the rural development plans under the reformed common agricultural policy are drawn up. Re0741

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E) Scenarios daNUbs (Overview)

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Tab. 11: Scenarios in the Danube Basin with corresponding C, N, P (and S) balances of the total system nutrition with Agriculture: Plant and Animal nutrition, Human nutrition and Waste as well as Waste Water Management
Period: 2000- (2012) 2015
(G= Germany, A= Austria, CEE= Central and Eastern European EU)

Scenarios ➔ *with corresponding sustainable criterions*	**Agriculture: Plant and Animal nutrition** (also Feed Industry) ➔ Feed production and consumption, Food production	**Human nutrition** (also Food Industry) ➔ Food processing and consumption	**Waste and Waste Water Management** (Infrastructure Sewage, TP) ➔ Nutrient removal and recycling
Scenario1: **Business as usual (BAU)** **= Status quo** ➔ ***Weak efficiency,*** no further urbanisation	Situations like 1995-2000 (Consolidation) G+A: No change, subsidies	Situations like 1995-2000 (unhealthy nutrition, esp. G+A) G+A: No change CEE: No change	Situations like 1995-2000 G+A+ CEE: only operation and maintainance of existing infrastructure
Scenario 2: **Worst Case (WC)** **= Global Markets (GM)** ➔***Strong Efficiency*** Urbanisation	Export oriented, within EU and globally G+A: like 1995-2000 CEE: like 1989 Specialisation of plant and animal production (esp. CEE)	G+A: like 2000 CEE: like 1989	Sewerage: all settlements > 2000 pe Treatment: Carbon removal as minimum requirement (normal areas) Sludge: Incineration
Scenario 3: **Best Available Technique (BAT)** ➔ *Strong Efficiency* ***and Consistency*** Urbanisation like Scenario 2	Additionally reduction of nutrient emissions by BAT ➔ "Unavoidable" emissions resting G+A+CEE: better state than in 2000	G+A: like 2000 CEE: like 1989	Sewerage: all settlements > 2000 pe Treatment: nutrient removal as minimum requirement (sensitive areas) Sludge: 50% Incineration, 50% reuse

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Tab. 11 Continued: Scenarios in the Danube Basin with corresponding C, N, P (and S) balances of the total system nutrition with Agriculture: Plant and Animal nutrition, Human nutrition and Waste as well as waste water Management
Period: 2000- (2012) 2015
(G= Germany, A= Austria, CEE= Central and Eastern European EU)

Scenarios ➔ *with corresponding sustainable criterions*	**Agriculture: Plant and Animal nutrition** (also Feed Industry) ➔ Feed production and consumption, Food production	**Human nutrition** (also Food Industry) ➔ Food processing and consumption	**Waste and Waste Water Management** (Infrastructure Sewage, TP) ➔ Nutrient removal and recycling
Efficiency + Consistency *+**Sufficiency***	**S U S T A I N A B L E D E V E L O P M E N T**		
Scenario 4: **Sustainability / Green** **= Regional Markets (RM)** ➔ *Efficiency + Consistency* *+**Sufficiency*** Urbanisation lesser than Scenario 2+3	Need oriented feed and food production / Structural changes: Integrated need oriented plant and animal production G+A+CEE Optimised foreign trade with feed and food (imports and exports) ➔ Simultaneously economical, ecological and social optimisation	Healthy food consumption (esp.animal fat +protein/meat) Need oriented food consumption D+A+CEE	Sewerage: improved on site treatment and reuse Treatment: nutrient removal as minimum requirement (sensitive areas) Sludge: 20% Incineration, 80% reuse
Scenario 5: **Policy Scenario** **= Weak Sustainability** Urbanisation like Scenario 2	Expected situations according to the present and proclaimed (inter-)national laws and directives as well as intensions and their implementations regarding agriculture, Human nutrition and Waste as well as Waste Water Management(i.e. also intensions of ICPDR (2001/2005) for N and P emission reduction)		
	Nitrate directive (1991) IPPC-directive (1996) UN/ECE (1999) + NEC/EU (2000)directives Agenda of Rio (1992) Agenda 2000 of the EU (1999) EU water framework directive (2000) National directives	Open declarations for food Recommendations for healthy nutrition	Sewerage: all settlements > 2000 pe Treatment: Carbon removal as minimum requirement (normal areas) and improved treatment if ambient water quality requires it. Sludge: 50% Incineration, 50% reuse
Scenario 6: **Consistency Black Sea (CBS)** Urbanisation like Scenario 2	**Nutrient management in the Danube Basin oriented on the critical levels and loads of the N and P inputs from the delta into the Black Sea: Critical nutrient loads and environmental limits for the Western Black Sea** *Based on tolerable natural loads of N, P and Si from the Danube Basin to the Black Sea sets of measures are combined in a way that this goal of tolerable emissions / immissions reach in a most cost effective way. The question is what are the minimum requirements in nutrient management (agriculture, human nutrition, waste water management) in the Danube Basin to reach prerequisites for a stable development of the Black Sea ecosystem.*		

Re0595 Scenarios overview daNUbs final , Danubs III

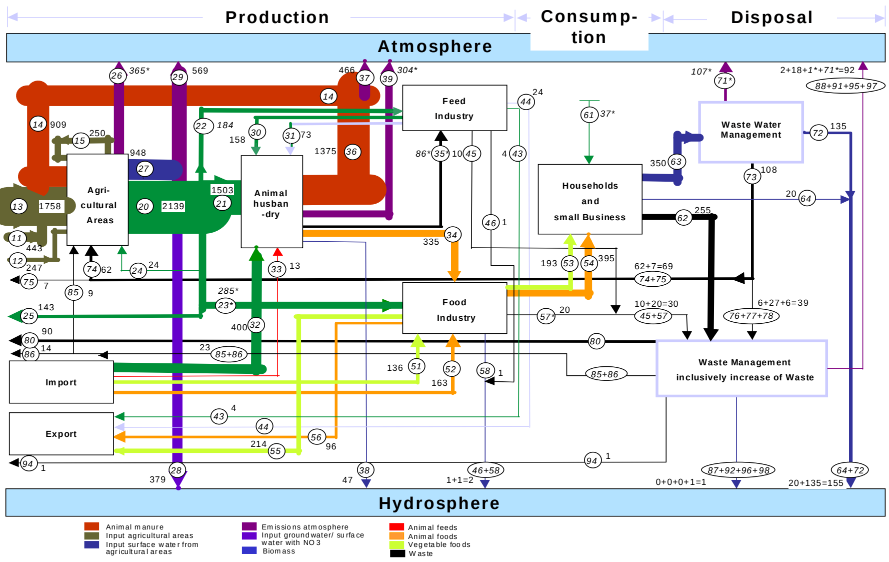

Fig.6: Nitrogen balance of Germany [ktN·yr^{-1}]: Agriculture, Feed-and Food-Industry/Business, Waste and Waste Water Management (Reference years 1995/1998) [ATV/DVWK 2001] re0548

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F) Detailed nutrient managments

F1) Best available techniques (BAT) diffuse sources, esp. Agriculture

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Option

Please use an x to indicate experience et

description	code	rejected	literature research	lab scale	plot / field scale	watershed scale	part of regulation etc.
A. Options for reducing agricultural nitrogen and phosphorus input or increasing output							
Reduction of input							
Nutrient balance below 100% for plots with (very) high P,N status (depletion)	*A1*	x					x
Other plots: make input equal to offtake of P,N with crops	*A2*		x		x	x	
Reduce fertiliser inputs to:							
a -- arable land	*A3*		x		x	x	
b -- grassland	*A4*		x		x	x	
c -- horticulture	*A5*		x		x	x	
Afforestation of arable land (no further N,P input)	*A6*						x
Increasing output							
Choose crops with higher P- or N-uptake	*A7*		x				
Remove crop residues after harvest	*A8*		x				
Livestock management							
Reduce feed P- or N-input to dairy	*A9*		x				
Use phytase to reduce feed P input	*A10*		x				
Use low phytate feed	*A11*		x				
B. Options for reducing (conversion to) soluble forms of P,N							
Soil residual P management							
Immobilising amendments to soil	*B1*		x				
Ploughing soil for reducing stratification	*B2*		x		x		
Fertiliser management							
Slowly available P,N fertilisers	*B3*		x				
Incorporation of inorganic or organic fertilisers	*B4*		x		x		x
Placement near crops	*B5*		x		x		
Timing windows for application	*B6*		x		x		x
Precision farming	*B7*		x				
Composting of crop residues	*B8*		x		x		
Manure management							
Change from liquid to solid manure	*B09*		x		x		
Injection of liquid manure	*B10*		x		x		x
Incorporation	*B11*		x		x		x
Timing windows for application	*B12*		x		x		x
Immobilising amendments to manure	*B13*		x				
Reduce rate of application and redistribution of manure	*B14*		x		x		
Separate solid and liquid manure fractions (makes transport cheaper)	*B15*		x				
Recycle P,N from animal manure	*B16*		x				
Livestock management							
Reduce stocking density	*B17*		x		x	x	
Stop animal production (locally)	*B18*		x		x	x	
Restrict livestock access in marginal places/times	*B19*		x		x	x	
Use plastic for grass silage (decreases risk of P,N in silage effluent)	*B20*				x		
Miscellaneous							
Removal of tile drains and ditches draining high risk lowland organic soils in order to reduce mineralization of these soils	*B21*		x				

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Option

Please use an x to indicate experience et

description	code	rejected	literature research	lab scale	plot / field scale	watershed scale	part of regulation etc.
A. Options for reducing agricultural nitrogen and phosphorus input or increasing output							
Reduction of input							
Nutrient balance below 100% for plots with (very) high P,N status (depletion)	*A1*	x					x
Other plots: make input equal to offtake of P,N with crops	*A2*		x		x	x	
Reduce fertiliser inputs to:							
a -- arable land	*A3*		x		x	x	
b -- grassland	*A4*		x		x	x	
c -- horticulture	*A5*		x		x	x	
Afforestation of arable land (no further N,P input)	*A6*						x
Increasing output							
Choose crops with higher P- or N-uptake	*A7*		x				
Remove crop residues after harvest	*A8*		x				
Livestock management							
Reduce feed P- or N-input to dairy	*A9*		x				
Use phytase to reduce feed P input	*A10*		x				
Use low phytate feed	*A11*		x				
B. Options for reducing (conversion to) soluble forms of P,N							
Soil residual P management							
Immobilising amendments to soil	*B1*		x				
Ploughing soil for reducing stratification	*B2*		x		x		
Fertiliser management							
Slowly available P,N fertilisers	*B3*		x				
Incorporation of inorganic or organic fertilisers	*B4*		x		x		x
Placement near crops	*B5*		x		x		
Timing windows for application	*B6*		x		x		x
Precision farming	*B7*		x				
Composting of crop residues	*B8*		x		x		
Manure management							
Change from liquid to solid manure	*B09*		x		x		
Injection of liquid manure	*B10*		x		x		x
Incorporation	*B11*		x		x		x
Timing windows for application	*B12*		x		x		x
Immobilising amendments to manure	*B13*		x				
Reduce rate of application and redistribution of manure	*B14*		x		x		
Separate solid and liquid manure fractions (makes transport cheaper)	*B15*		x				
Recycle P,N from animal manure	*B16*		x				
Livestock management							
Reduce stocking density	*B17*		x		x	x	
Stop animal production (locally)	*B18*		x		x	x	
Restrict livestock access in marginal places/times	*B19*		x		x	x	
Use plastic for grass silage (decreases risk of P,N in silage effluent)	*B20*				x		
Miscellaneous							
Removal of tile drains and ditches draining high risk lowland organic soils in order to reduce mineralization of these soils	*B21*		x				

Re0777a

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Option description	code	rejected	literature research	lab scale	plot / field scale	watershed scale	part of regulation etc.
		Please use an x to indicate experience et					
E. Options for reducing P,N transport in surface water							
Purify water, e.g. in infiltration beds	*E1*		x				
Sedimentation ponds	*E2*		x		x		
Barrier ditches (linear sedimentation ponds)	*E3*		x				
Increase retention time in ditches (stimulates deposition of particulate P,N)	*E4*		x		x		
Constructed wetlands	*E5*		x				
Immobilising amendments to constructed wetlands	*E6*		x				
Remove sediments from streams (dredging)	*E7*					x	
Place removed sediments within field (not on ditch border)	*E8*					x	
Immobilising amendments to sediments	*E9*		x				
Prevent that eutrofied surface water enters P,N-sensitive water (re-routing)	*E10*		x				
Restore river channels and thereby letting river water temporary inundate floodplains for retention of particulate or organic P,N	*E11*		x				
Stop weed cutting and channel dredging (streams and ditches); this will in the longer run give same results as *E11*	*E12*		x				
Reestablishing of raised bogs, wetlands and lakes	*E13*		x				
F. Options for abating consequences of eutrophication in surface water							
Stimulate growth of submerged water plants	*F1*		x				
Remove biomass from ditches and streams (e.g. reed, duck-weed)	*F2*		x			x	
Place removed biomass within field (not on ditch border)	*F3*		x				
Biomanipulation (e.g. remove sediment resuspending fish)	*F4*		x				
Increase lake depth (reduces resuspension of sediment by wind)	*F5*		x				
Flushing lake water with 'clean' surface water	*F6*		x				
Other options, not mentioned above, please give description							
G. Legal options / measures maintaining or even increasing nutrients P, N in surface water and groundwater (i.e. German Düngeverordnung 2006)							
1. Only incomplete total field balances, no farm gate balances, no individual field/plot balances; therefore:	G1				x		x
1.1 compension of (too) high with (too) small N and P plot surpluses	G2				x		x
1.2 neglecting "small" inputs of 50 and 30 kg/ ha.yr of N and P2O5 resp.	G3				x		x
1.3 neglecting N inputs i.e.by atmospheric deposiiton,late N for cereals and to straw	G4				x		x
2. Tolerated P surpluses of 20 kg P2O5/ha . yr of P hypertrophied soils (38%)	G5				x		x
3. Ca. 50% too high maximum of tolerated (reactive) gaseous N emissions of 45% (grazed grassland 75%!) from animal N excretions	G6				x		x
4. No best available techniques (BAT) for reducing gaseous N emissions are required	G7				x		x
5. 4-5 fold too high "tolerable" maximum farm gate N surpluses of 175-245 kg N/ha . yr for arable crops/grassland between 2006 and > 2011	G8				x		x
6. 2 fold too high "tolerable" N surpluses of max.160 kg N/ha .yr for vegetable crops	G9				x		x
7. Promoting industrial (3,3-4,3 AU/ha instead of agricultural animal production (< 1,0 AU/ha) with P surpluses of 61-79 kg P2O5/ha.yr, also by EU subsidies => ca. 8% increase of animal stockings till 2010, ca. 140% more animals than needed for a healty human nutrition with animal food	G10				x		x
8. Too short prohibition times for N and P fertilization of only 3,0 (arable land) and 2,5 (grassland) months during winter times instead of 6,0 months	G11				x		x
9. No humus/ C-balances => EC No 1782/2003 (Gross compliance/ modulation)	G12				x		x
10 No penalties if there are offences against Düngeverordnung	G13				x		x

re0777c

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F) Detailed nutrient managments

F2) Healthy Human nutrition (food consumption) and corresponding need oriented food production

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Tab. 15: Shares of nutrition associated cases of death on total death cases
(Mortality Statistic Germany 1997) and Nutrition Report 2000 (DGE 2000)

Causes of death	Cases of death: numbers	%	Risk factors of nutrition associated causes of death				
1. Total	**860 389**	**100**					
2. ...off them: nutrition associated	**666 829*)**	**[78]**	**Causes of death nutrition associated**	**Risk factors (++= probable; += possible; - = not clear)**			
...off them:				**Total fat**	**Animal fat**	**Saturated fatty acids**	**Red meat**
2.1 Circulatory troubles	415 800	(48)	**Cardiac infarctation [1)]**	++	-	+	-
2.2 Cancer	210 053	(25)	**Breast cancer[2)]**	-	-	-	+
2.3 Hepato-cirrhosis	18 617	(2)	**Prostatic cancer[3)]**	+	+	+	+
2.4 Diabetes mellitus	22 359	(3)	**Lung cancer[4)]**	+	+	+	+
			Stomage cancer[5)]	-	-	-	**(+) grilling**
			Colon cancer[6)]	+	+	+	**++ Grilling,Roasting, meat products+**
3. ...off them:							
a) Car accidents	**8 100**	(1)					
b) Tobacco	**125 000**	(15)					
c) Alcohol	**42 000**	(5)					

[1)] also: Coffee **(++)**
[2)] also: Alcohol and overweigth **(++)**
[3)] also: Alcohol **(+)**
[4)] also: Alcohol **(+) only limited nutrition associated**
[5)] also: Salt preserves **(++)**: Nitrosamines, Frying, Pickling, Smoking **(? !)**
[6)] also: Alcohol **(++),** Eggs, Sugar **(+)**

***) without lung cancer (37 240): 629 589 (73)**

re0544

Tab. 16: Shares of costs and cases of death associated with nutrition, tobacco, alcohol and illegal drugs in Germany

	Yearly costs: Mrd €	€ · capita $^{-1}$ [1)]	%	Cases of death: Mio · yr^{-1}	%
Total public health	(1993): 168 (1995): 194 (1997): 204 (1999): 214 (2001): 226 (2003):	2049 2366 2488 2610 2756	100	860 400 (ca. 1% of the population:82 Mio) (statistics of mortality 1997)	100
...off them associated with **1. Nutrition (overnutrition)**	Wolfram (1998): **51** DGE (2000): **66** GfED/BMG (2004): **77**	**622** **804** **939**	**ca. 30**	**666 800** (statistics of mortality 1997) [630 000 without lung cancer]	**78** [77]
2. Tobacco [2)] (Dt. KFZ 2002)	(1993): 27-44	329 – 536	16-26	(1993):125 000	15
3. Alcohol (Robert Koch Institut 2002)	(1995): 20	244	10	(1995): 42 000 [+Tobacco: 74 000]	5 [7]
4. Illegal drugs (BMG 2002)	k. A.	k.A.	k.A.	(2001): 2000	< 1

[1)] Compare: Average old age pension ca. 8 700 € · captita^{-1} · yr^{-1}
[2)] Conservative: without smoker, consultation, research, weaning, prophylaxis

re0542

Tab. 17: Recommended average reference values for dietary intake/consumption of energy, nutritious matters [protein, fat, carbohydrates, dietary fibre (alcohol)] and for net meat of males and females [individually differing in respect to sex, pregnancy and nursing, age, abnormal weight (BMI > 22/24) and physical activity level (PAL)] in comparison with their average dietary intake/consumption i.e. in Germany 1993 and in Western Germany (1985/89)

Average dietary Intake/ Consumption (Average person: 41 years, 66 kg, expectancy: ♂ 74/ ♀ 81= 78 years)	Reference values [BMI< 22/24] (DGE 1996, 2000, 2001)	Germany 1993 (n= 38924) (DGE 2000)		Western Germany (1985/89) DGE 1996) % reference values
		Units · capita^{-1}	% reference values	
1. Energy (kcal· d^{-1})	2100 (2013)	2295	**114**	99
2. Protein (g · d^{-1}) **(% Energy)**	DGE 2001: 53 49 (46) 10-15	76,6 13	**145; 156 (166)**	**155**
3. Fat (g · d^{-1}) **(% Energy)**	70 25 – max. 30	94,2 **36**	**136**	**127**
4. Carbohydrates (g · d^{-1}) **(% Energy)**	275 55-60 (> 50)	257 **45**	**94**	**83**
….off them Disaccharides **(% Energy)**	67 10	73 **15**	**109**	n.d.
5. Dietary fibre (g · d^{-1})	30 (27,3)	20,1	**74**	**65**
6. [Alcohol] (g · d^{-1}) **(% energy)**	(adults max: 15) -	13,1 **4**	-	-
7. Meat (Net)[1)] (without self production)				
7.1 Intake (DGE) (g·d^{-1}) **(g·w^{-1})** **(kg·yr^{-1})**	64 (43-86) 6 x 75 = 450 (300-600) 23,4 (15,7-31,4)	129 [75]900 46,9	**200 (327)**	n.d.
7.2 Consumption[1)] (BMELF) (g ·d^{-1}) **(g·w^{-1})** **(kg·yr^{-1})**	- - -	172 [100]1204 62,8	**268**	**286**

1) Meat without bones, wasted fat, industrial utilisation, feed, losses (ca. 67% of gross meat consumption)

Re0527

Tab. 18: Linkage between sustainable and healthy human nutrition with animal food and corresponding needed sustainable animal production of agriculture exemplarily shown for Germany in 2000 (BMVEL 2001)

Animal food	Sustainable / Healthy human nutrition		Corresponding needed animal production of agriculture with 0.1 AU· cap^{-1} = 50 kg life weight
	Needed animal food (kg· cap^{-1} · yr^{-1}) ➔ Tab. 12	Milk equivalents (kg· cap^{-1} · yr^{-1})	
Milk and milk products	**Milk: 45.6 (4.2% fat)** **Butter: 2.9 (80% fat)** **Cheese: 7.3** (i.e. Emmentaler: 8 kg cheese = 100 kg milk)	46 55 91 **Total: 192**	Milk cows: 1 AU = 6127 kg milk· yr^{-1} 32% of animal stock = 16 kg life weight with **196 kg milk· cap^{-1} · yr^{-1}**
Meat	**23.4**		50 kg life weight x 49% efficiency of meat yield **= 24.5 kg meat· cap^{-1} · yr^{-1}** **➔ Tab. 21**
Eggs	**3.7** **= 60 eggs with 62 g · egg^{-1}**		**60 eggs x 276 eggs· laying hen^{-1} · yr^{-1}** **= 0.22 laying hens· cap^{-1} · yr^{-1}**

Re0604

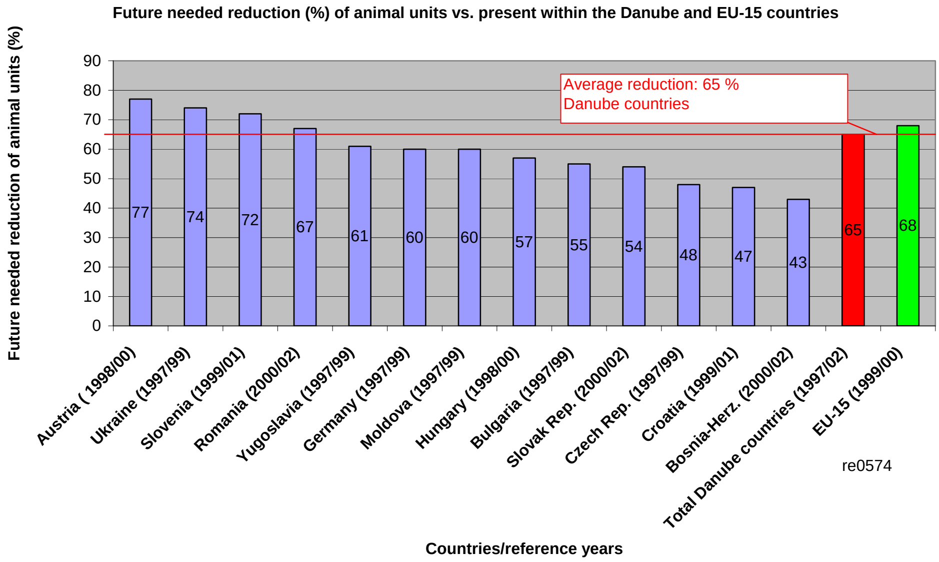

Fig. 7

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Tab. 19: Necessary reduction of animal production and livestock of agriculture both in the countries of EU-25+2 and in the Federal lands of Germany on the basis of the actual capita-specific animal densities (AU · capita^{-1}) in comparison with a maximum tolerable animal density of 0.1 AU= 50 kg life weight · capita^{-1} (Isermann 1995/2006) **according to a healthy human nutrition with animal food, especially with meat [Net: max. 23,4 kg meat · capita^{-1} · year^{-1} (DGE 2000/01) instead of actually i.e. in Germany (2002):60 kg · capita^{-1} · year^{-1}]**
[Actual animal stockings and densities according to EUROSTAT 2005]

Countries	Actual Animal densities (AU · capita^{-1})	Necessary Reduction Livestock (%)	Countries	Actual Animal densities (AU · capita^{-1})	Necessary Reduction Livestock (%)	Federal Lands of Germany	Actual Animal densities (AU · capita^{-1})	Necessary Reduction Livestock (%)
1.Ireland	1.606	-94	14. Hungary	0.263	-62	1. Schleswig-Holstein	0.466	-79
2.Denmark	0.846	-88	15. Bulgaria	0.254	-61	2. Niedersachsen	0.456	-78
3.France	0.390	-74	16. Estonia	0.241	-59	+Hamburg		
4.Belgium	0.382	-74	17. United kingdom	0.240	-58	+Bremen		
5.Netherlands	0.380	-74	18. Greece	0.238	-58	3. Mecklenburg-Vorp.	0.404	-75
6.Cyprus	0.359	-72	19. Finland	0.227	-56	4. Bayern	0.311	-68
7.Luxemburg	0.355	-72				5. Sachsen-Anhalt	0.252	-60
8.Spain	0.341	-71				6. Thüringen	0.232	-57
9.Lithuania	0.339	-71	**20. Germany**	**0.226**	**-56**	**Deutschland**	**0.226**	**-56**
10. Austria	0.308	-67	21. Portugal	0.226	-56	7. Sachsen	0.156	-36
11.Romania	0.304	-67	22. Czech.Republic	0.224	-55	8. Nordrhein-Westf.	0.154	-35
			23. Sweden	0.205	-51	9. Baden-Württemb.	0.140	-29
EU-15	**0.294**	**-66**	24. Latvia	0.197	-49	10. Brandenburg	0.130	-23
12.Slovenia	0.293	-66	25. Slovakia	0.177	-44	+Berlin		
13. Poland	0.292	-66	26. Italy	0.174	-43	11. Hessen	0.106	-6
EU-25+2	**0.290**	**-64**	27. Malta	0.123	-19	12. Rheinland-Pfalz + Saarland	0.094	+7
EU-10+2	**0.275**	**-64**						

Re0785

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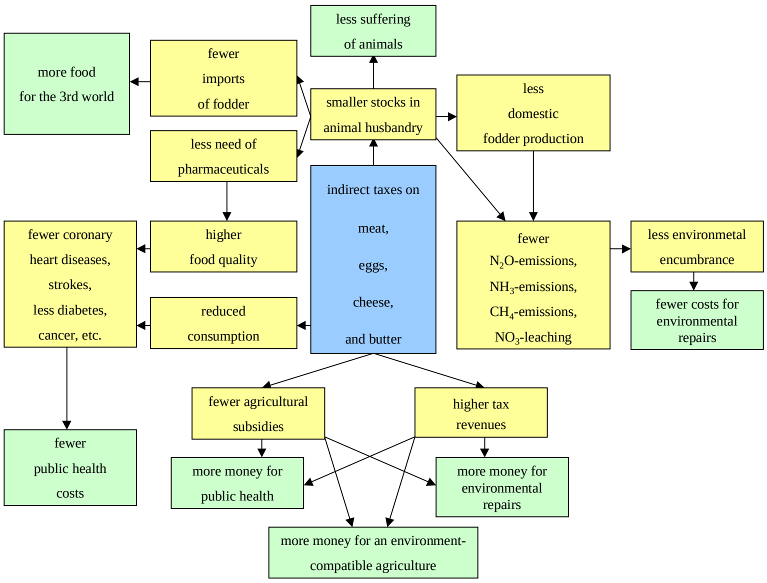
Fig. 8: Tax Levy Model for Animal Products to Relieve the Environment and Public Health (van der Ploeg 2002) (re0530)



Tab. 20: Reduction of average Nitrogen (N) and Phosphorus (P) dietary intake and excretion by need oriented (optimal) and need adapted human nutrition in Germany

Human nutrition	Intake and excretion (g capita^{-1} · d^{-1}) → Input waste and waste water sector	
	Nitrogen (N)	Phosphorus (P)
1. Actually (1993) unhealthy: Overnutrition with energy, protein and fat [DGE 2000]	76.6 g Protein: 6.25 = **12.3 g N [100]**	**1.261 g P [100]**
2. Need oriented healthy (optimal): Realistic (Isermann 2004)	64.7 g Protein: 6.25 = **10.4 g N [85]**	**1.215 g P [96]**
3. Need adapted (Reference values): Not realistic [DGE 2000/2001]	53.0 g Protein: 6.25 = **8.5 g N [69]**	**0.700 g P [56]** (DGE 1992: 1.316 g P)

Re0538

→ Realistic need oriented healthy human nutrition will reduce N and P excretion and input into the waste and waste water sector of only about 15 and 4% respectively and not realistic need adapted human nutrition will reduce it of about 31 and 44% respectively

Tab. 21: Summary of the reference values:
A) both for healthy human nutrition especially with animal food consumption
B) and corresponding sustainable agriculture especially with animal food production
C) with practically no impacts on waste and waste water

A) HUMAN NUTRITION					B) AGRICULTURE	C) WASTE AND WASTE WATER
Energy Nutritious matters Meat	Average total daily intake per capita	Animal food consumption: % Share	Animal food consumption: Daily intake per capita	Maximum animal stocks	Animal food production: Maximum animal densities with optimum conditions (i.e. nutrient supply of soils)	
1. Energy	2100 kcal	20	420 kcal		Maintenance balances :	Practically no impacts of human nutrition and agriculture on the N and P inputs into waste and waste water
2. Protein % Energy	53g 10-15	40	21 g		1. C : 2.0 t ROS . ha-1 . yr^{-1}	
3. Fat % Energy	70g 25-30	50	35 g		2. N : Output with yield + (20-) 50 kg N· ha^{-1} · yr^{-1}	
4. Meat	64g	100	64 g		3. P: Output with yield ± 0 kg P· ha^{-1} · yr^{-1}	
5. Phosphorus	700 mg	(30)	(210 mg)	➔ Maximum animal unit (AU) equivalent : 0.1 AU· $Capita^{-1}$ (= 50 kg animal live weight)	➔ Maximum animal densities: (> 0.4-) 1.0 AU· ha^{-1}	
6. Carbohydrates % Energy	275 g 50-60	- -	- -			
7. Dietary crude fibre	30f	-	-			

Re0600

F) Detailed nutrient managments

F 3) Policy management system :
(Inter-)national legislation

Table 22: **Present international → and i.e. national legislation in the total nutrition system of agriculture with plant and animal nutrition, human nutrition, waste and waste water management** referring
- to environmental spheres Pedosphere, Hydrosphere, Atmosphere and Biosphere (Lithosphere not considered)
- as well as to the nutrients involved Carbon (C), Nitrogen (N), Phosphorus (P) and Sulphur (S)

Environmental spheres		**Pedosphere (Soil)**	**Hydrosphere (Water)**	**Atmosphere (Air)**	**Biosphere (Flora and fauna)**
Nutrients involved		**C, N, P, S**	**C, N, P, S**	**C, N, S**	**C, N, P, S**
Nutrition System	**Agenda 21 of Rio (1992) vs Agenda 2000 EU (1999)**	**Agenda 21 of Rio (1992) vs Agenda 2000 EU (1999)**			
Agriculture with Plant nutrition and animal nutrition		▪EU communication on soil protection (2002) : Thematic strategy for soil protection → DE:Soil regulation (1999) → OE : ÖPUL (2000) ▪EC Cross compliance /modulation 1782/2003 (CAP) → DE : DirektZahl Verpfl. V (draft 2004) → OE: Invekos-Ums VO (draft 2004)	▪ Drinking water directive (98/83 EU) ▪Nitrates directive (CD 91/676/EC) →DE: Düngeverordnung (1996) Draft (2005) → AT: ÖPUL (2000) Nitraktionsprogramm (2003) → NL: MINAS (1998/2006) • Draft Groundwater Directive (KOM /2003, 550 final) ▪ Water Framework Directive (2000/60EC) ▪ EU Marine Strategy (2004)	▪Kyoto-Protocol (1997) ▪IPCC Directive 96 / 61 / EC Integrated pollution prevention and control (1996) ▪UN/EC Protocol (1999) ▪NEC-Directive 2001/81/EC ▪Ozon Directive (2003/3/EC) → DE: - Artikelgesetz (2001) - 4. BimSchV. (2001) - Baugesetzbuch § 201 (2004)	▪UN-Convention of Biological Diversity (CBD/1999) ▪ E_Habitat Directive 82/43/EEC (Natura 2000) ▪ EU-ICZM ▪Recommendation (30.05.2002)
Human nutrition		Recommendations daily intake: Reference values for: energy, protein, fat, (carbohydrates) and their shares of animal food as well as for meat 1. EURODIET (2000): EU population goals for nutrients and features and lifestyle consistent with the prevention of major public health problems in Europe 2. DACH (2001) National reference values in DE, AU, CH (approximately consistent with EURODIET 2000) 3. Präventionsgesetz (Germany 2005)			
Waste and waste water management		▪ Sewage sludge directive CD 86/278 / EEC ▪ Urban wastewater directive CD 75/442/EEC ▪ Landfill directive CD 1999/31/EC	▪Bathing Water Directive 76/160/EEC ▪ Urban wastewater directive (UWWD-91/271/EEC, version RL 98/15) EC ▪ Water Framework Directive 2000/61 / EC	▪ Incineration Directive 2000/79 / EC	Re0626

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Tab. 23: Maximum tolerable N surpluses of agriculture in Germany from:
1. **Field balances with so-called "unavoidable" N surpluses according to the fertilizing regulation (13th January 2006)**
   - **1.1 Incomplete according to the fertilizing regulation with "expected" optimum fertilization: without atmospheric N-deposition, late N to cereals and N to cereal straw, respectively**
   - **1.2 Complete with atmospheric N-deposition, late N to cereals and N to cereal straw, respectively**
2. **Corresponding farm gate balances with gaseous N losses (90% NH_3N, 10%: N_2-N, N_2O-N, NO- N)**
3. **Compared with sustainable maximal N surpluses from farm gate balances considering both ecological, social and a.o. therefore also economical aspects**

Fertilizing Regulation (13th January 2006)					
Generally: Not essential N imputs: < 50 kg total-N · $ha^{-1} \cdot yr^{-1}$					
Maximum "unavoidable" N surpluses (kg N · $ha^{-1} \cdot yr^{-1}$)					
Time : Ø fertilizing years	**1. Field balances**				**2. Farm gate balances**
	1.1 incomplete [1)]	**1.2 complete**			**complete**
	without : -atmospheric N deposition - late N to cereals - N to cereal straw	with: -atmospheric N deposition 20-60 kg N · $ha^{-1} yr^{-1}$	with: -late N to cereals: 33% AA with late N: 60 kg N · $ha^{-1} yr^{-1}$ => 20 kg N · $ha^{-1} yr^{-1}$	with: - N to cereals straw 33%AA with 80 kg N · $ha^{-1} yr^{-1}$ => 25 kg N · $ha^{-1} yr^{-1}$	with: - gaseous N losses i.e. 45% of N excretion of 1 animal unit (90 kg N · $ha^{-1} yr^{-1}$ => 40 kg N · $ha^{-1} yr^{-1}$
2006 -2008	**90**	**110 - 150**	**130 – 180**	**155 – 205**	**195 - 245**
2007 -2009	**80**	**100 - 140**	**120 – 160**	**145 – 185**	**185 - 225**
2008 -2010	**70**	**90 - 130**	**110 – 150**	**135 – 175**	**175 - 215**
2009 - > 2011	**60**	**80 - 120**	**100 – 140**	**125 – 165**	**165 - 205**

[1)] Additional "unavoidable" maximum N surpluses for the cultivation of vegetables : max: 50-160 kg N · $ha^{-1} yr^{-1}$(max. 230 kg N · $ha^{-1} yr^{-1}$ as animal manure!)

3. Compared with: Sustainable maximum N surpluses from farm gate balances (kg N · $ha^{-1} yr^{-1}$)			
3.1. BNLA (1995/2005) to 2015: **20- 50 with max.:** **1.0 AU · ha AA^{-1}** **0.1 AU · $capita^{-1}$**	**3.2. DVGW (2002/2004)** **15-50**	**3.3. UBA (2002)** **30 – 50**	**3.4. SRU (2004)** **40** **with max. 1.0-1.5 AU · ha AA^{-1}**

Re0737

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Tab. 24: „Unavoidable" gaseous N losses with animal manure as well as tolerated with them maximum animal densities and P excretions according to the fertilizing regulation of Germany (13th January 2006) compared with sustainable NH_3-N losses and P excretions shown by 2 examples (arable land/liquid manure from fattening pigs and 3 x cutted + 1 x grazed grassland) respectively

	Arable land / liquid manure from fattening pigs	3x cutted and 1x grazed grassland/ liquid manure and urine/excretion from dairy cows (6200 kg milk · cow^{-1} · yr^{-1} (1st Amending regulation 10/01/06)
Maximum applicated N (kg N· ha^{-1} · yr^{-1})	**170 (Compare Austria: Total N input 170)**	**230 (compare Austria: Total N input 210)**
"Unavoidable" gaseous N losses (90% NH_3-N) a) % b) (kg N· ha^{-1} · yr^{-1})	**a) 40 b) 105**	**a) 28 b) 89**
Tolerable NH_3-N losses (kg N· ha^{-1} · yr^{-1})	10 (actually: 29)	10 (actually: 29)
Maximum tolerated N excretion (kg N· ha^{-1} · yr^{-1})	262	319
N excretion of 1 animal unit ≙ tolerable animal density (kg N· ha^{-1} · yr^{-1})	6.25 fattening pig places (≙ 16 pigs · yr^{-1}) Feeding: a) monophasic: 73 b) more phasic: 61	96 (115 · cow^{-1} · yr^{-1})
Tolerated animal densities (AU· ha^{-1}) (1 AU ≙ 500 kg life weight)	**a) monophasic: 262/ 73 = 3.6 (58 fatteining pigs) b) more phasic: 262/61 = 4.3 (69 fattening pigs)**	**319 / 96 = 3.3 (≙ 2.8 cows)**
...with tolerated P excretion (kg P_2O_5 · ha^{-1} · yr^{-1})	**a) monophasic: 139 (P surplus: 79) b) more phasic: 110 (P surplus: 38)**	**2.7 x 40 = 108 (P surplus: 108-47= 61)**
Tolerable P excretion with 1 AU (kg P_2O_5 · ha^{-1} · yr^{-1})	a) monophasic: 38 (P surplus: 21) b) more phasic: 26 (P surplus: 9)	34 (P surplus: 17)

Re0738

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Tab.25: A) Maximum tolerated „unavoidable" P-surplus of soils with optimal and hypertrophied P contents according to the fertilizing regulation in Germany (13 /01 /2006)
B) Compared with maximum sustainable P surpluses

	A) Maximum tolerated P surpluses Fertilizing Regulation Germany (13.01.2006) [kg P_2O_5 · ha^{-1} · yr^{-1}]	B) Maximum sustainable tolerable P surpluses [kg P_2O_5 · ha^{-1} · yr^{-1}]
1. Not essential P input	30	± 0
2. Classification Soil-P (mg CAL-/DL-P_2O_5 · 100g $soil^{-1}$)		
2.1 Optimal (C): 10-20 (25)	20 [1)]	± 0 (also VDLUFA)
2.2 Hypertrophied:		
2.2.1 (D): 21-34	20 [1)]	< 0 no P fertilisation
2.2.2 (E): > 35	20 [1)]	< 0 (also VDLUFA) no P fertilisation

Re0739

[1)] Compare Mineral accounting system (MINAS) of the Netherlands:
2003: Tolerated P surplus: 20 kg P_2O_5 · ha^{-1} · yr^{-1} : The EC condemned MINAS in 2003 also a.o. causes because levy-free surpluses were too high
2004: Consequently maximum tolerated P surplus was reduced to 1.0 kg P_2O_5 · ha^{-1} · yr^{-1}

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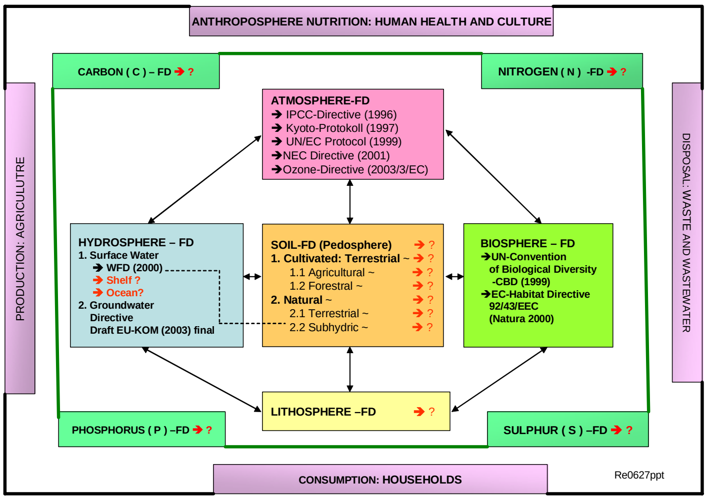
Tab. 26: Existing (➔) and needed (➔) Framework Directives (FD) in the anthroposphere nutrition on the fundamentals of the Agenda 21 of Rio (1992) and related to the main nutrients C, N, P, S, (fossil) energy and contaminants (i.e. heavy metals,xenobiotics)



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G) Impacts Scenarios daNUbs

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Tab.27 : Characteristics of Scenarios daNUbs

		2000	Sc1	Sc2	Sc3	Sc4	Sc5
Population total	10^6 inh.	82,1	77,2	77,2	77,2	77,2	77,2
Population urban	10^6 inh.	57,6	54,2	54,2	54,2	54,2	54,2
Population rural	10^6 inh.	24,5	23,0	23,0	23,0	23,0	23,0
Specific P-emissions	gP/(inh.d)	3,6	3,6	4,7	3,00	2,50	3,00
Connections to sewers	% of total inh	62	62	80	80	78	80
Connections to wwtp	% of total inh	47	47	80	80	78	80
Mechanical wwtp	% of total inh.	6	6	0	0	0	0
Biol. wwtp with C-removal	% of total inh.	21	21	56	17	16	39
Biol. wwtp with N,P removal	% of total inh	20	20	24	63	62	41
N-efficiency of treatment	% of inflow to wwtp	50	50	45	69	70	56
P-efficiency of treatment	% of inflow to wwtp	57	58	51	77	77	62
Animal density: Area specific	**AU/ha_{AA}**	**0,49**	**0,49**	**0,73**	**0,73**	**0,20**	**0,56**
Animal density: Inhabitant specific	**AU/inh**	**0,24**	**0,24**	**0,38**	**0,38**	**0,10**	**0,28**
Use of mineral fertilizer	kgN/(ha_{AA}.a)	33	33	65	48	25	44
N-efficiency of plant production*	**%***	**64**	**65**	**65**	**62**	**66**	**60**
Surplus on agricultural area	**kgN/(ha.a)**	**29**	**29**	**58**	**47**	**22**	**40**
Reduction of tile drainage	% of drained area	0	0	0	20	20	10
NH3-N deposition reduction	% of Sc0	100	100	119	100	78	104
Erosion abatement**	% of arable land	0	0	0	50	100	0

* N-in harvested crops in relation to N input (fertiliser, deposition, N-fixation) re0653
** Minimum tillage, mulch techniques, i.e. mulch seeding ; intercropping

Tab. 28: N-surpluses (Field balance = Soil surface balance) and Animal Dung Units (ADU) of agriculture in the Danube-13 countries and EU-15 in reference 1999 = Scenario Business As Usual (BAU) (Behrendt 2004)

Countries	N- surplus		ADU · ha AA^{-1} *)
	kg · ha · AA^{-1}	%	
1. Germany (Bavaria and Baden-Württemberg) [DE]	**81.6**	**301**	**1.29**
2. Slovenia [SI]	**73.9**	**273**	**1.14**
3. Czech Republic [CZ]	**47.4**	**175**	**0.53**
4. Austria [AT]	**43.6**	**161**	**0.80**
5. Croatia [HR]	**34.1**	**126**	**0.26**
6. Republic of Slovakia [SK]	26.5	98	0.40
7. Romania [RO]	22.8	84	0.41
8. Hungary [HU]	22.5	83	0.29
9. Moldova [MD]	20.0	74	0.30
10. Bosnia-Herzegovina [BH]	17.5	65	0.31
11. Bulgaria [BG]	15.5	57	0.34
12. Ukraine [UA]	13.4	49	0.23
13. Serbia-Montenegro [CS]	13.3	49	0.45
14. Average Danube Countries (DC-13)	**27.1**	**100**	**0.52**
15. Average EU-15	**57.1**	**210**	**0.88**

*) ADU: Animal Dung Unit according German and Austrian definition: 80 kg N · yr^{-1} with organic manure (excretion: ca. 100 kg N · yr^{-1})
Re0636

Tab. 29: **N surplus (Field balance = Soil surface balance) in agriculture of the individual 13 Danube countries (DC-13) according to the scenarios 1- 5 of daNUbs**

Danube Countries (DC)	Scenarios daNUbs (D 3.1/ 3.2 and D 3.3)									
	1.Reference 1999 = Business as usual		**2. Worst case: Global Markets**		**3. Best available Technique**		**4. Sustainable (Green): Regional Markets**		**5. Prognosis: Policy**	
	N – Surplus in Agriculture (Soil surface = Field balance) [Behrendt 2004]									
	kg ·ha^{-1} yr^{-1}	**%**	**kg ·ha^{-1} yr^{-1}**	**%**	**kg ·ha^{-1} yr^{-1}**	**%**	**kg · ha^{-1} yr^{-1}**	**%**	**kg · ha^{-1} yr^{-1}**	**%**
1. DE: BW+ BY	81.6	100	80.9	99	74.4	91	43.4	53	87.4	**107**
2. SI	73.9	100	75.7	**102**	60.0	81	48.1	65	60.2	81
3. CZ	47.4	100	97.3	**205**	79.9	**169**	30.1	64	44.9	95
4. AT	43.6	100	43.4	**100**	33.6	77	23.4	54	52.1	**119**
5. HR	34.1	100	46.2	**135**	36.6	**107**	18.8	55	27.7	81
6. SK	26.5	100	75.0	**283**	61.7	**233**	31.3	**118**	39.8	**150**
7. RO	22.8	100	52.1	**229**	41.1	**180**	19.3	85	31.5	**138**
8. HU	22.5	100	61.7	**274**	48.7	**216**	18.8	84	43.6	**193**
9. MD	20.0	100	47.6	**238**	37.7	**189**	19.1	96	33.4	**167**
10. BH	17.5	100	38.9	**222**	30.9	**177**	22.2	**127**	31.6	**181**
11. BG	15.5	100	54.4	**351**	42.4	**274**	11.9	77	21.2	**137**
12. UA	13.4	100	39.6	**296**	31.3	**234**	13.6	**101**	22.0	**164**
13. CS	13.3	100	69.9	**526**	55.4	**417**	16.7	**126**	41.1	**309**
Average: DC -13	27.1	100	58.1	**214**	46.7	**172**	21.0	77	38.9	**144**

Re0635

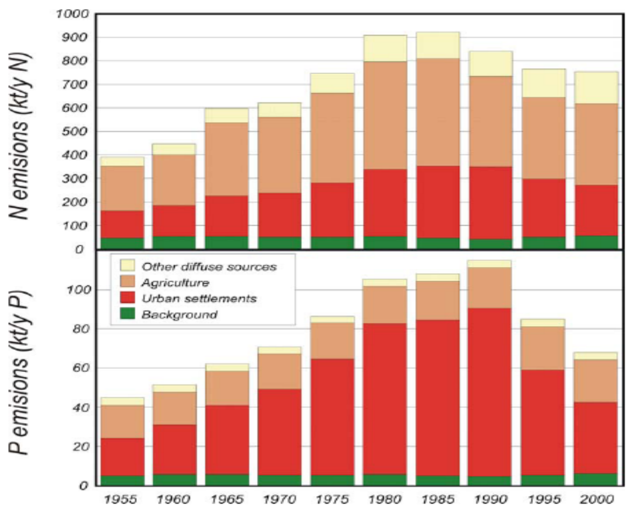

Fig.9 : Changes of nitrogen and phosphorus emissions into the river system of the Danube from 1955 to 2000

re0786

Table 30:
1. Average N-surplus of agriculture within the Danube Basin (kg $\cdot$ha^{-1} $\cdot$ yr^{-1})
[Soil Surface Balance = Field balance] and
2. Total Input of N and P (kt $\cdot$ yr^{-1}) of point and diffuse sources to the Delta of the river Danube (➔ Black Sea)
A) Reference situations: at present (2000) [100]
B) with different Scenarios 1- 5

Situations [Isermann, K. , Isermann., R., Zessner, M.: D3.1/3.2, D3.3 2004]	1. N-surplus agriculture (kg $\cdot$ha^{-1} $\cdot$ yr^{-1}) [Behrendt 2004]	2. Input to the Delta (diffuse + point sources) (kt $\cdot$ha^{-1} $\cdot$ yr^{-1}) [van Gils 2004] N	P
A) Reference situations: at present (1999/2000)	27.1 (100)[1)]	451 (100)	20.2 (100)
B) Scenarios:			
1. Business as usual (BAU)	27.1 (100) [1)]	406 (90)	18.6 (92)
2. Worst case: Global Markets (WC ➔ 1989)	58.1 (214) (100)	493 (109) (100)	26.3 (130) (100)
3. Best available technique (BAT)	46.7 (172) (80)	410 (91) (83)	12.0 (59) (46)
4. Sustainability: Regional Markets (Green Scenario)	21.0 (77) (36)	310 (69) (63)	8.8 (44) (33)
5. Prognosis: Policy	38.9 (143) (67)	424 (94) (86)	19.7 (98) (75)

[1)] Compare: Bavaria + Baden-Württemberg: 81.6
Ukraine: 13.4

re0628

Tab. 31: Die Wasserrahmenrichtlinie – Bestandsaufnahme 2004 in Deutschland (BMU 2005)
1/2

	Oberflächengewässer				Grundwasser
	Flüsse	**Seen**	**Küsten- und Übergangsgewässer**	**Oberflächen-gewässer**	
1. Zielerreichung (%)					
1.1 unwahrscheinlich	**62**	**38**	**86**	**60**	**53**
1.2 unsicher	**26**	**24**	**7**	**26**	**-**
1.3 wahrscheinlich	**12**	**38**	**7**	**14**	**47**
2. Ursachen für Zielverfehlung (Prioritäten 1-3)	n = 8850	n = 780	n = 70	n = 9700	n = 980
2.1 Nährstoffe	**2**	**1**	**1**	**2**	**1**
2.2 Hydromorphologie	1	2	3	1	-
2.3 weitere Schadstoffe	3	3	2	3	-
2.4 sonstige Belastungen	-	-	-	-	2
2.5 Wasserentnahme	-	-	-	-	3

Anzahl in n = 10 Flussgebietsberichten
- Gewässerstruktur (einschl. Durchgängigkeit): 10
- **Nährstoffe: 6**
- Physikalisch/chemische Stoffe: 6
- Prioritäre Stoffe: 5

% Anteil von Grundwasser-körpern
- Diffuse Quellen: hauptsächlich Nährstoffe: 88
- Sonstige Belastungen (z.B. andere Stoffe, Grundwasserabsenkungen: 25
- Menge / Entnahmen: 8

Re0663a

Tab. 31: Die Wasserrahmenrichtlinie – Bestandsaufnahme 2004 in Deutschland (BMU 2005)
2/2

<table>
<tr><th colspan="3">3. Wesentliche Ergebnisse und Schlussfolgerungen</th></tr>
<tr><td rowspan="2">3.1 Fließgewässer</td><td>▪ In den meisten Bundesländern und somit in nahezu allen deutschen Flusseinzugsgebieten ist die Gewässermorphologie durch den Menschen auf weiten Strecken verändert und beeinträchtigt
▪ In den Stadtstaaten zeichnet sich ab, dass ein guter ökologischer Zustand der Gewässer kaum erreicht werden kann, was insbesondere auf die intensive wirtschaftliche Nutzung und damit auf dauerhaft veränderte Gewässermorphologie zurückzuführen ist.</td><td></td></tr>
<tr><td>▪ Ein großer Teil der Flüsse und Bäche wird die Umweltziele der WRRL ohne konsequente Umsetzung entsprechender Maßnahmen zur Verbesserung des Gewässerzustandes voraussichtlich verfehlen (=> Bezug zum Meeresschutz?)</td><td rowspan="5">Diffuse Quellen: Bei Nährstoffen [insbesondere N, (und P)], Schwermetallen, Pestiziden und einer Reihe weiterer Schadstoffe spielen diffuse Quellen eine größere Rolle als Punktquellen. Der Anteil der diffusen Einträge lag für N –bezogen auf den Gesamteintrag- in den Jahren 1998/2000 in Deutschland bei rund 80%, für P bei rund 70%. Die Mengen sind dort besonders groß, wo hohe Tierbestände auf austragsgefährdeten Böden (?) gehalten werden. Trotz deutlicher Reduktionen der Emissionen sind Nährstoffgehalte in den Gewässern auch heute noch immer zu hoch. Bei der Bestandsaufnahme haben die Bundesländer insbesondere Einträge von N- und P-Verbindungen sowie von Pestiziden beurteilt. Für alle 3 Stoffgruppen gilt, dass sie in erster Linie von landwirtschaftlich intensiv benutzten Flächen stammen.</td></tr>
<tr><td>3.2 Seen</td><td>Die häufigste Ursache dafür, dass ein See die Umweltziele der Richtlinie möglicherweise verfehlt, sind zu hohe Nährstoffbelastungen</td></tr>
<tr><td>3.3 Küsten- und Übergangsgewässer</td><td>Auch für diese ist die Eutrophierung das gravierendste Problem</td></tr>
<tr><td>3.4 Alle Oberflächengewässer</td><td>Quelle von Nähr- und Schadstoffbelastungen der Oberflächengewässer ist in erster Linie die Landwirtschaft, gefolgt vom Abwasser- und Regenwassereinleitungen</td></tr>
<tr><td>3.5 Grundwasser</td><td>▪ Für die hohe stoffliche Belastung vieler Grundwasserkörper sind meist Nährstoffeinträge aus landwirtschaftlich (=> und forstwirtschaftlich) genutzten Flächen verantwortlich. Etwa 85% der Grundwasserkörper, die die Ziele der WRRL derzeit wahrscheinlich nicht erreichen würden, sind durch Stoffeinträge aus diffusen Quellen beeinträchtigt</td></tr>
</table>

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H) Driving and preventing forces for the implementation / development of a sustainable nutrition system i.e in Germany

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Tab. 32a:
Driving and preventing forces in the development / implementation of a sustainable nutrition system i.e. in Germany

Sectors of Sustainability ➔ Aims	**Development / Implementation of a sustainable nutrition system** **Driving forces** **➔ otherwise collapse feedback**
Social conditions ➔ Sufficiency **[needed food]**	**Overnutrition associated human diseases (morbidity) and causes of death (mortality)** e.q. to 77 billions € · yr^{-1} (2004) representing ca. 78% of total cases and 30% of total medical costs **➔ collapse of both (public) health and pension insurance systems**
Environment ➔ Consistency [of natural-near ecosystems and natural nutrient resources (esp. N and P)]	1. **Needed ca. 80% reduction of the emissions esp. of reactive C,N,P (S) to environment** esp. by agriculture, human nutrition > waste and waste water management **➔ collapse by environmental disasters** like eutrophication, acidification, climate change (=> globalisation needed), change and decline of biosphere 2. **Exhaustion of nutrient resources like N (fossil energy) and mineral P** **➔ Collapse of N and P resources**
Economy ➔ Efficiency [optimization output / input = food / nutrients]	1. **Win / win situations** 1.1 Agricultural products not cheap but worth their prices socially, environmentally and economically implemented by tax levy esp. for animal food 1.2 No further subsidies for agriculture 1.3 Reduction (public) health costs by overnutrition 1.4 Reduction environmental costs 1.5 More food for the Third Word 1.6 Decreased cruelty to animals 2. **Best available techniques (BAT)** **➔ Collapse economically, esp. of agriculture**

re0791a

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Tab. 32 b: Driving and preventing forces in the development / implementation of a sustainable nutrition system i.e. in Germany

Sectors of Sustainability ➔ Aims	**Development / Implementation of a sustainable nutrition system** **Preventing forces** **(Inter-)National Lobbies ➔ Lobbyism ➔ Corruption**	
Social conditions **➔ Sufficiency** **[needed food]**	1. Instead pf Net economic growth **Cross economic growth** (Cross national product /GNP) **vs. Sufficiency** 2. **Apparent efficiency vs. sufficiency (Best) Available Techniques vs. Sufficiency** 3. **Ignorance of overnutrition**	1. **Widespread (inter-)national corruption, esp. in respect to legislation, jurisdiction and execution referring to production, trade, consumption, esp. of animal food and environmental problems,** mainly by: ▫ Farmers organisations ▫ Organisations of: Fertilizer-, Feed-, Food-, Industries and Trade ▫ Waste and Waste Water Authorities together with ▫ Governmental institutions like ministries 2. **No ratification of the UN conventions against corruption in Germany:** Corruption of governmental members are tolerated and not punished **Main sectors and institutions involved in corruption in Germany (Rank 16):** ▫ Political parties ▫ Parliament ▫ Business ▫ Justice ▫ Police ▫ Tax offices ▫ Information systems (anti-Transparency) ▫ Public Health System ▫ (Military) ▫ Education System [Transparency International (2006), Friedrich-Ebert-Foundation, 2006), Hoefken (2006)]
Environment **➔ Consistency** [of natural-near ecosystems and natural nutrient resources (esp. N and P)]	**Ignorance of:** 1. **environmental problems** i.e. global climate change 2. **Exhaustion of natural/nutrient resources i.e. of N (fossil energy) and mineral P**	
Economy **➔ Efficiency** [optimization output / input = food / nutrients]	1. **Price dumping** i.e. of agricultural products/food, esp. EU/WTO ➔ Globalisation 2. **Low Taxation and Subsidy policy** (agriculture and food) 3. **Unfair trade** 4. **Illegal (shadow) economy:** i.e. Germany most important economic sector with 15% of GNP (2006) ➔ increasing tendency **➔ Index of Sustainable Economic Welfare** (Cobb and Cobb 1990)	

re0791b

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Summary

1. Results and conclusions of the EU-RP-5 “daNUbs” [EVK-CT-2000-0051 (2-2001/1-2005)] “Nutrient Management in the Danube River Basin and its impact on the Black Sea” are shown. As scenarios 1-6 more or less sustainable mitigation options to reduce the N and P inputs into the Danube River Basin and therefore into the P limited Western Black Sea are shown both cause-oriented and sufficiently in an integrated manner referring to the entire nutrition system: Agriculture with plant and animal nutrition (diffuse sources), Human nutrition (households intervenient) as well as waste and waste water management (point sources).

2. N surpluses of agriculture are closely related to animal production and consumption.

3. Especially in respect to the requirements of the EU-Water Framework Directive (2000) and Draft Groundwater Directive (2003/2006) the scenario 3 shows that single best available techniques (BAT) are not sufficient to get good chemical and ecological status of the Danube River Basin and Black Sea with interfering groundwater and terrestrial ecosytems.

4. Global (agricultural /market strategies (Scenario 2) as well as actual national (i.e. German Düngeverordnung 2006) and international (EU) policy (Scenario 5) increases eutrophication, for example with Nitrate Directive (1991), WFD (2000) and Draft Groundwater Directive (2006). Their threshold value of max. 50 instead of 10 mg NO_3/l are 5fold too high that can be tolerated in respect to corresponding critical levels and loads.

5. Only sustainable bundles of measures based on sufficiency primarily of a healthy human nutrition with corresponding production especially of animal food (max. 0.1 animal unit = 50 kg life weight·capita^{-1}) flanked simultaneously by BAT (efficiency) are adequate to reduce N and P inputs into the aquatic ecosystems both cause-oriented and sufficiently (consistency). This are a.o. also the options of the EU-COST-ACTION 869 “Mitigation options for nutrient reduction in surface water and groundwater (11/2006-11/2011).

Summary Graz 2007