

Indication of Ecosystem Services in different Asian rice cropping areas

Anja Müller, Benjamin Burkhard, Felix Müller

Institute of Nature and Resource Development
Christain-Albrechts University, Kiel, Germany

The "Mission"

- Field trip from 03.05.-14.06.2012 to Vietnam and the Philippines in order to conduct expert surveys for the valuation of Ecosystem Functions and Services
- Use results to conduct spatially explicit maps about the ESS/ESF provision
- Part of LEGATO research project

The Regions

Seven research regions as defined in LEGATO



My Tho Province, Mekong Delta

- Highly developed infrastructure
- Intensive cultivation of rice fields - three harvests a year
- High input of fertilizer + pesticides
- Relatively low structured landscapes



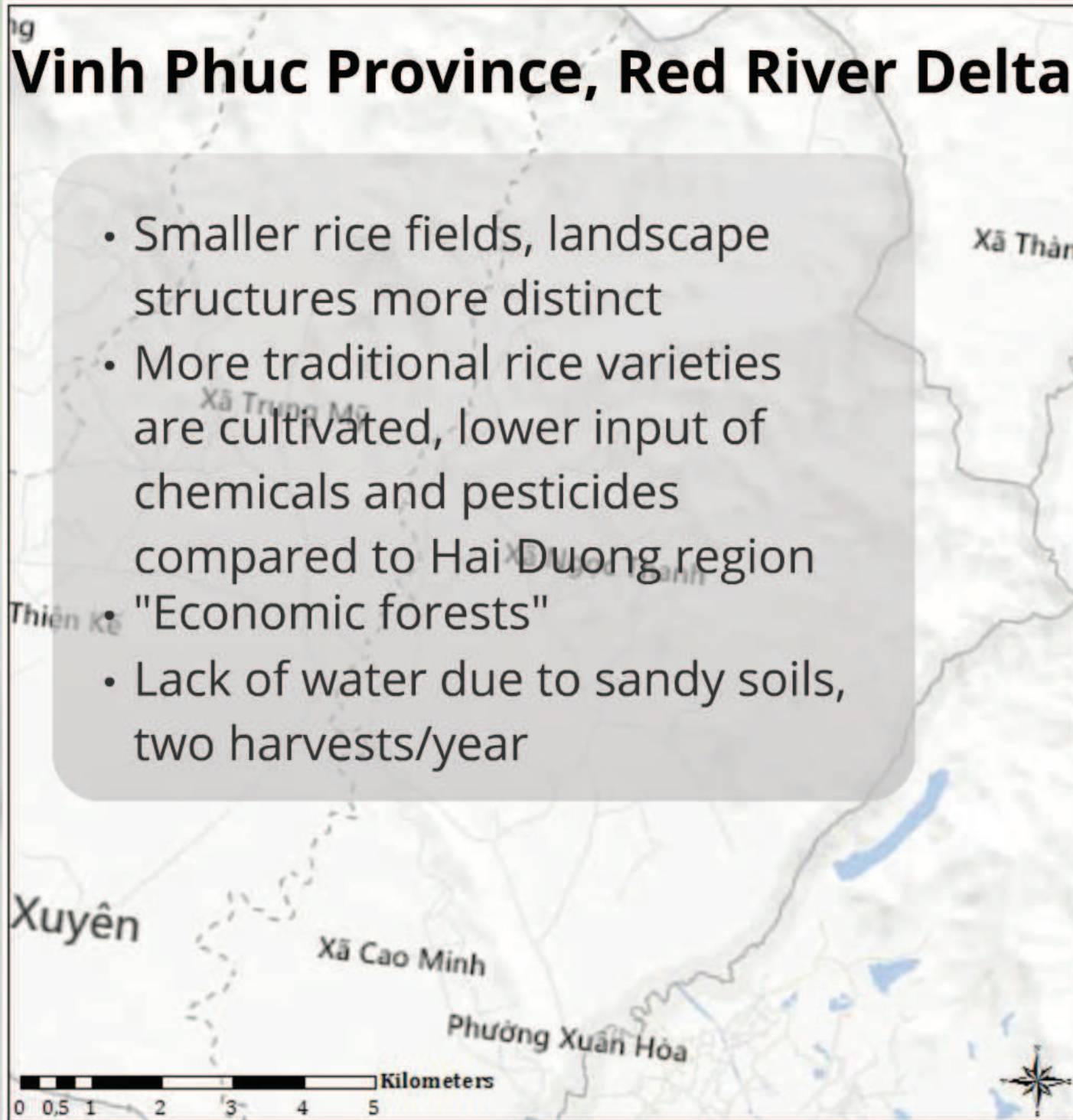
Hai Duong Province, Red River Delta

- Highly productive area for rice cultivation, high input of fertilizer/pesticides
- Well developed infrastructure
- Changes in land use from agriculture to industrial/settlement areas



Vinh Phuc Province, Red River Delta

- Smaller rice fields, landscape structures more distinct
- More traditional rice varieties are cultivated, lower input of chemicals and pesticides compared to Hai Duong region
- "Economic forests"
- Lack of water due to sandy soils, two harvests/year



Sa Pa, Lao Cai Province/North Vietnam

- Terraced rice cultivation - self-subsistent, no markets
- Relatively low chemical inputs, low productivity (one successful harvest/year)
- Increasing corn production due to water scarcity
- Declining forest cover, landslides



0 0,5 1 2 3 4 5 Kilometers



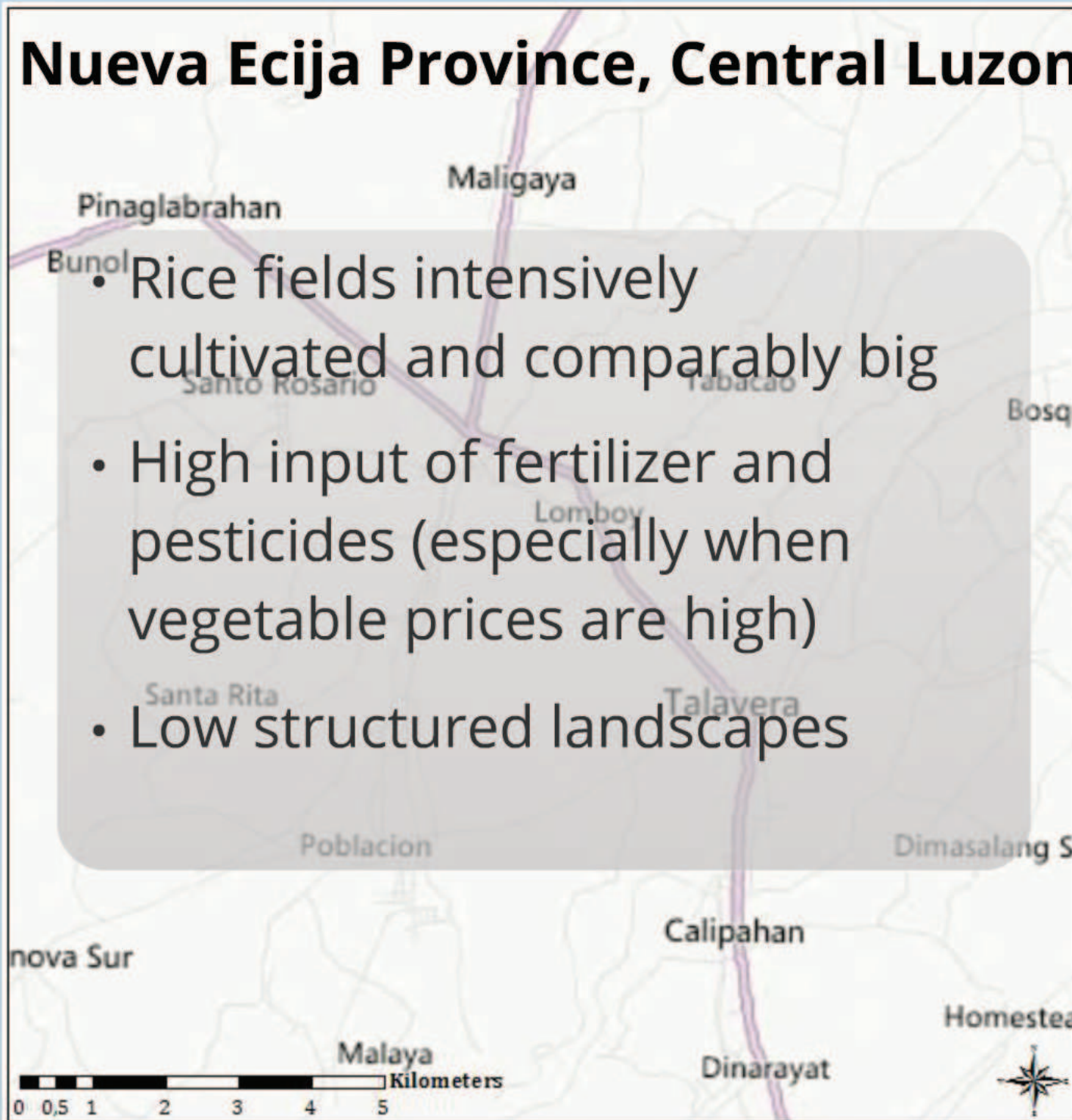
Laguna Province, Central Luzon

- Region borders the biggest freshwater lake in the Philippines
- Two rice harvests/year, mainly along river tributaries
- Despite rice, also corn, fruits and vegetables are grown



Nueva Ecija Province, Central Luzon

- Rice fields intensively cultivated and comparably big
- High input of fertilizer and pesticides (especially when vegetable prices are high)
- Low structured landscapes



Banaue, Ifugao Province

- Rice cultivation on terraces - low productivity, traditional varieties, low input of chemicals and pesticides
- Landslides due to infrastructural developments
- Labour scarcity in agriculture due to increase of tourists

0 0,5 1 2 3 4 5 Kilometers





Indication of Ecosystem Service capacities

Methodology and procedures

Introductory Presentation

- Ecosystems and their functions
- The concept of Ecosystem Services
- Methodology and procedures



Methodology and procedures

Complexity of the system
Complexity of the data
Complexity of the analysis
Complexity of the interpretation



From different and data sources

The Expert Surveys

The Questions

7. **Biodiversity**
measures the presence and absence of important species or the appearance of different functional groups of insects and molecules of semi-volatile components.

→ On a scale from 0 to 5, how would you rate the biodiversity in the different land cover types of the research region?

0 1 2 3 4 5

2. Primary Production

→ These animals give milk their young offspring but not usually to another individual (e.g. the cheetah)

The common-sense view

1. **Introduction**
 2. **Background**
 3. **Methodology**
 4. **Results**
 5. **Conclusion**
 6. **References**

Methodology and procedures

- Introduction of the 10 different Ecosystem Functions and Services which were defined as relevant for rice cropping systems in LEGATO
- After having described every Ecosystem Function/Service, the participants were asked to rate the ESS/ESF-capacity of each significant land use / land cover class of the specific investigation area



Methodology and procedures

Introductory Presentation

- Ecosystems and their functions
- The concept of Ecosystem Services
- Methodology and procedures



Methodology and procedures

- The regions as defined in LEGATO were visualized using Satellite Pictures in A3-Format
- Next step was to explain the different land use / land cover classes identified as relevant, using photos from the area



The 14 different Land use / land cover types

Land use / land cover type	Legend
1. Agricultural land	Green
2. Forest	Dark Green
3. Urban	Grey
4. Water	Blue
5. Bare soil	Light Brown
6. Wetland	Dark Green
7. Pasture	Light Green
8. Shrubland	Dark Green
9. Grassland	Light Green
10. Forest	Dark Green
11. Urban	Grey
12. Water	Blue
13. Bare soil	Light Brown
14. Wetland	Dark Green

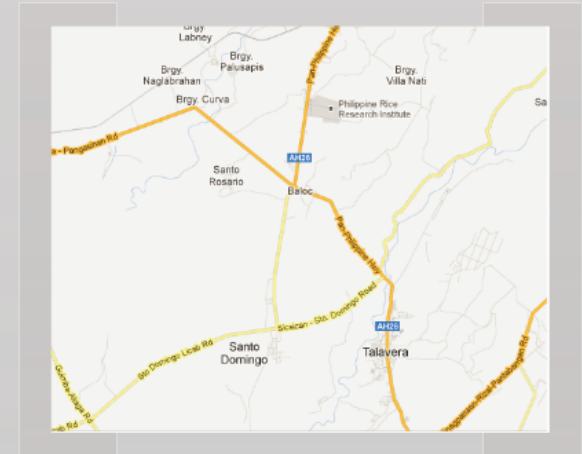


The 14 different Land use / land cover types



Methodology and procedures

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The 14 different land use / land cover types

class	land use/land cover type	description
1	water bodies	lakes, rivers
2	ancient forest	old-growth forest (not reforested)
3	forest	principally trees, also shrubs, bushes and storey
4	meadow/grassland	grass cover für grazing
5	highly sealed surface	houses and other buildings, streets..
6	low sealed surface	e.g. unpaved roads, partially sealed surfaces
7	fruit plantations	fruit trees, banana plantations, coconut trees..
8	irrigated rice	permanently irrigated rice fields
9	vegetable plantation	e.g. potatoes, eggplant, peppers, pumpkins
10	other agricultural land	agricultural land uses not covered by classes 7-9
11	leisure facilities	parks, camping and sports ground, golf courses..
12	mineral extraction sites	mines, gravel pits
13	wetland	bogs, marshes
14	bare areas	bare rock, sand..

[defined due to technical feasibility of classification]

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[defined due to technical feasibility of classification]



The 14 different Land use / land cover types



[illegible]

The survey questions

3. Nutrient Regulation



describes the capacity of an ecosystem to recycle nutrients, for example nitrate or phosphate. It can be estimated for example on the base of decomposition rates.

- How would you judge the nutrient regulation capacity in the different land use systems?

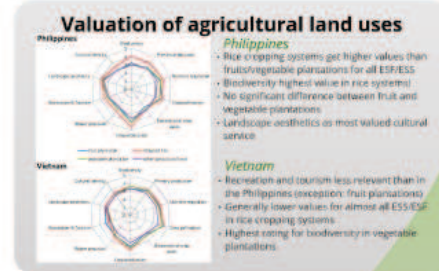
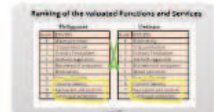
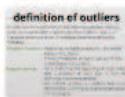
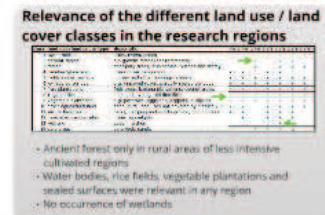
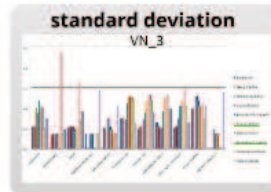
Methodology and procedures:

When finished, the ratings for each Ecosystem Function/Service (either 0,1,2,3,4 or 5) were compared - following there was a discussion revealing arguments for a high/low rating



- The resulting matrix built the foundation for creating maps about ecosystem services provision in each of the seven regions

Data Analysis



definition of outliers

In order to minimize the risk of false data interpretation, matrices have been scanned with respect to potential outliers - based on literature review and expert knowledge, these were defined as following:

- Ecosystem Functions:*
- Biodiversity on highly (values >3) / low sealed (values >4) surfaces
 - Primary Production on highly (values >2) / low sealed (values >3) surfaces
- Ecosystem Services:*
- For provisioning and regulating services, values with a deviation of more than 2 from the arithmetic mean were deleted
 - For cultural services, no outliers have been defined due to the highly subjective perception of this category

VN_1 Hai Duong		Ecosystem Functions									
code	Land use & land cover classes	1 Biodiversity	2 Primary production	Regulating services			Provisioning services		Cultural services		
				3 Nutrient regulation	4 Crop pollination	5 Biocontrol of crop pests	6 Crop production	7 Water provision	8 Recreation & Tourism	9 Landscape aesthetics	10 Cultural identity
1	water bodies	3.5	3.0	3.3	3.0	2.0	2.8	3.8	3.8	3.5	3.5
2	meadow/grassland	3.3	3.5	3.8	3.8	3.7	3.5	3.0	3.3	3.3	3.3
3	highly sealed surface	1.0	0.3	0.5	0.8	1.5	0.3	0.3	2.8	1.8	1.8
4	low sealed surface	1.8	1.3	1.3	1.3	1.5	0.8	0.8	2.8	1.5	1.5
5	fruit plantation	3.5	3.8	3.5	4.8	2.8	3.5	2.8	3.0	3.0	3.8
6	irrigated rice	3.5	4.0	3.5	4.3	2.8	3.5	3.0	2.8	3.0	4.0
7	vegetable plantation	3.5	3.8	3.8	4.8	2.8	3.8	2.8	2.8	3.0	3.5
8	other agricultural land	3.3	3.0	3.3	4.3	2.8	2.8	2.3	3.5	3.3	3.3
9	leisure facilities	1.8	1.0	0.8	1.3	2.0	0.5	0.8	4.3	4.5	2.8
10	mineral extraction	1.3	0.8	0.3	1.3	2.3	0.5	0.0	3.3	2.8	1.8
11	bare areas	1.5	1.3	2.0	0.8	0.3	0.5	0.9	1.8	0.8	1.5

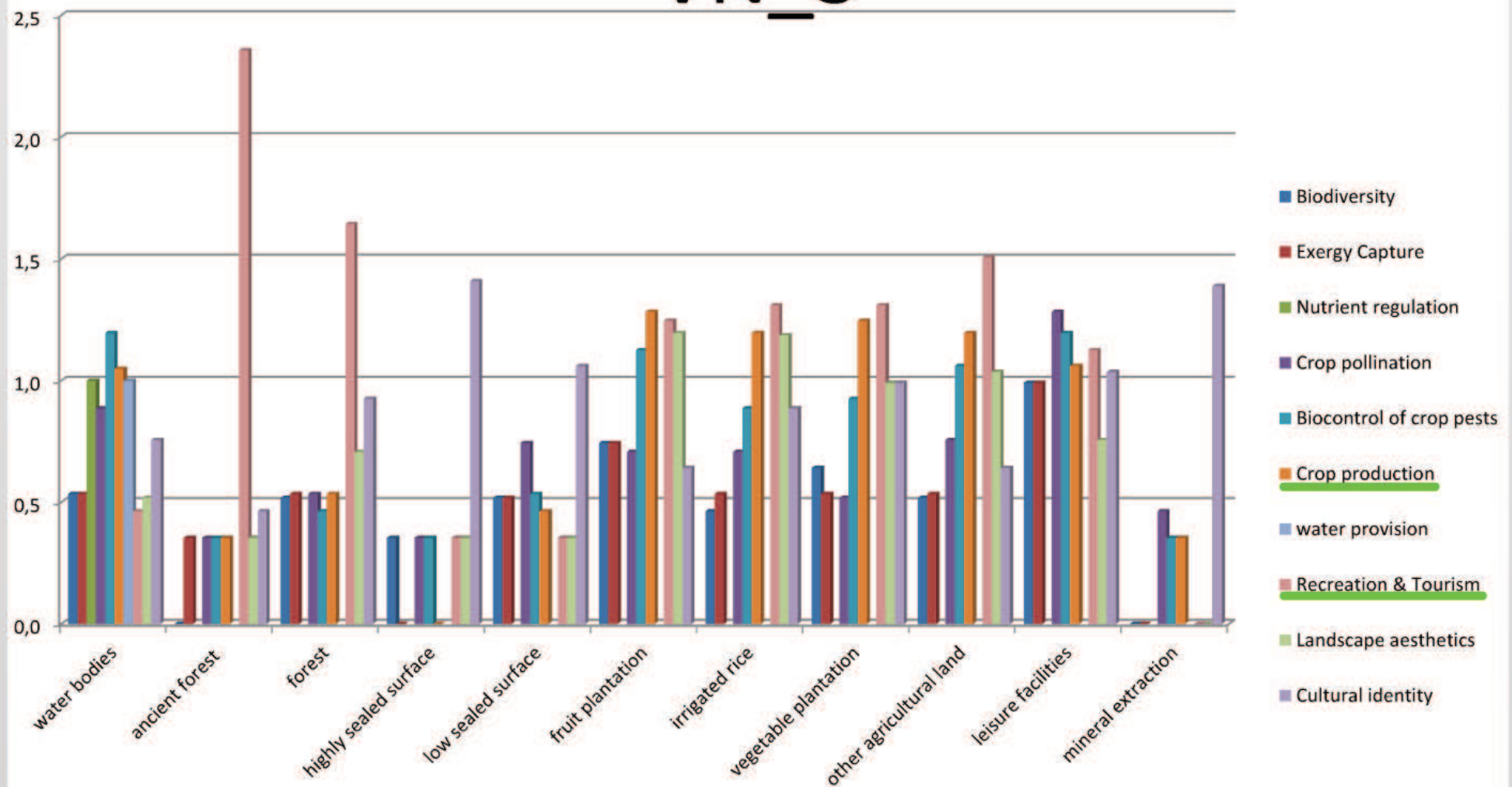
VN_3 Lao Cai		Ecosystem Functions									
code	Land use & land cover classes	1 Biodiversity	2 Primary production	Regulating services			Provisioning services		Cultural services		
				3 Nutrient regulation	4 Crop pollination	5 Biocontrol of crop pests	6 Crop production	7 Water provision	8 Recreation & Tourism	9 Landscape aesthetics	10 Cultural identity
1	water bodies	4.0	4.0	4.3	2.5	2.9	3.8	4.4	4.0	4.0	4.1
2	ancient forest	5.0	4.9	4.9	4.9	4.9	4.8	4.9	3.8	4.8	4.8
3	forest	4.4	4.5	4.5	4.8	4.5	3.6	4.3	3.6	4.0	4.1
5	highly sealed surface	0.1	0.0	0.1	0.1	0.0	0.1	0.1	1.6	0.6	0.5
6	low sealed surface	0.4	0.4	0.6	0.5	0.3	0.1	0.1	1.8	0.6	1.0
7	fruit plantation	3.4	3.4	3.3	4.4	2.4	3.9	3.3	3.1	3.1	3.4
8	irrigated rice	3.3	3.5	3.8	4.3	3.0	4.7	3.4	2.9	3.3	4.0
9	vegetable plantation	3.1	3.5	3.6	4.0	3.4	4.7	3.1	2.5	2.9	3.6
10	other agricultural land	3.4	3.5	3.5	3.6	3.0	4.0	2.8	2.3	3.1	3.8
11	leisure facilities	1.1	1.1	1.3	0.7	0.3	0.6	0.5	4.5	3.3	2.5
12	mineral extraction	0.0	0.0	0.3	0.1	0.1	0.0	0.0	1.3	1.3	0.4

VN_2 Vinh Phuc		Ecosystem Functions									
code	Land use & land cover classes	1 Biodiversity	2 Primary production	Regulating services			Provisioning services		Cultural services		
				3 Nutrient regulation	4 Crop pollination	5 Biocontrol of crop pests	6 Crop production	7 Water provision	8 Recreation & Tourism	9 Landscape aesthetics	10 Cultural identity
1	water bodies	3.7	3.7	3.7	2.7	2.3	2.3	4.3	3.7	3.7	2.7
2	ancient forest	4.0	3.7	4.0	4.0	3.3	2.7	4.7	4.0	4.3	4.0
3	forest	3.7	3.7	4.0	3.3	3.3	3.0	4.3	4.0	4.0	2.3
4	meadow/grassland	2.3	2.3	3.3	2.7	3.0	2.0	3.3	2.3	3.0	2.0
5	highly sealed surface	1.5	1.0	1.7	1.0	2.7	1.0	1.7	4.0	2.3	1.7
6	low sealed surface	2.0	2.0	2.3	1.7	2.7	1.3	2.3	2.7	2.3	2.3
7	fruit plantation	2.7	3.3	4.3	4.0	3.7	3.7	3.0	3.0	3.3	2.3
8	irrigated rice	3.7	3.3	4.3	4.7	3.7	4.3	3.3	2.3	3.0	2.0
9	vegetable plantation	3.7	3.3	3.7	4.3	3.7	3.7	3.0	2.0	2.7	1.7
10	other agricultural land	3.3	3.0	3.7	3.3	3.3	3.0	2.7	2.3	2.7	2.0
11	leisure facilities	2.3	2.0	2.7	2.0	2.7	1.7	2.0	4.3	3.7	3.3
12	mineral extraction	2.0	2.0	2.0	1.3	1.7	1.0	1.7	2.7	1.7	1.3
13	wetland	2.7	2.3	3.0	2.3	2.0	2.3	3.7	2.3	1.7	2.0
14	bare areas	1.3	1.7	1.3	1.3	2.7	1.3	1.7	1.0	1.0	1.0




VN_4 Tien Giang		Ecosystem Functions									
code	Land use & land cover classes	1 Biodiversity	2 Primary production	Regulating services			Provisioning services		Cultural services		
				3 Nutrient regulation	4 Crop pollination	5 Biocontrol of crop pests	6 Crop production	7 Water provision	8 Recreation & Tourism	9 Landscape aesthetics	10 Cultural identity
1	water bodies	3.8	3.4	2.7	0.0	2.7	0.3	4.6	4.0	4.4	4.0
2	forest	4.4	4.8	1.3	4.6	4.8	3.2	2.4	4.0	4.8	4.2
3	highly sealed surfaces	2.0	1.3	0.2	0.0	0.4	0.0	0.0	2.4	1.8	3.0
4	low sealed surface	2.3	1.4	0.2	0.0	0.0	0.0	0.0	1.8	1.4	2.0
5	fruit plantation	3.6	4.4	4.0	4.6	3.3	4.6	3.6	3.8	3.6	4.0
6	irrigated rice	4.0	4.4	4.2	4.2	3.6	5.0	3.8	3.0	3.6	3.6
7	vegetable plantation	4.2	4.4	3.8	4.0	3.4	4.4	3.6	2.8	3.4	3.6
8	other agricultural land	3.4	4.0	3.4	3.6	3.0	4.2	3.2	2.4	3.2	3.2

standard deviation

VN_3

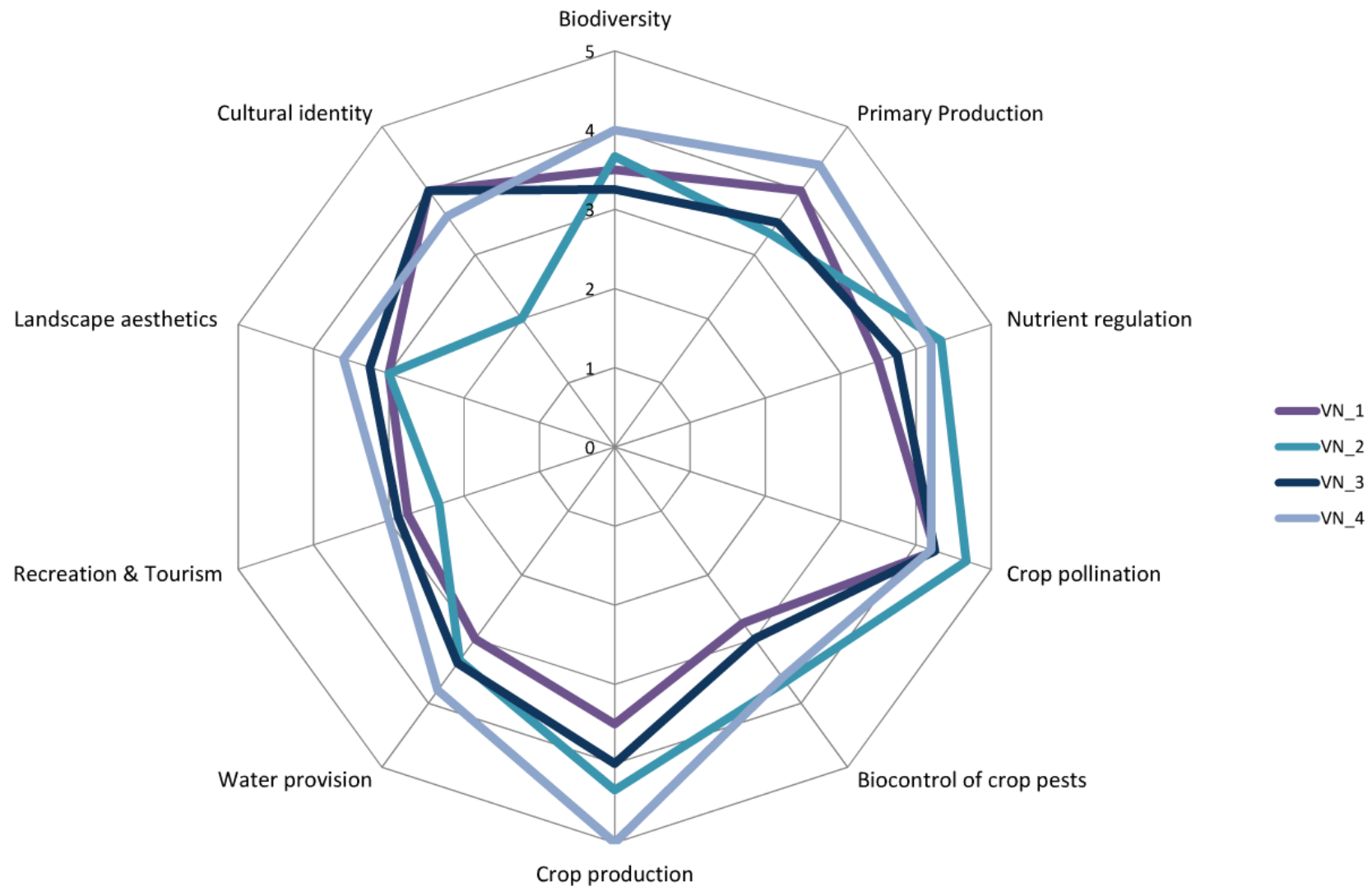


Relevance of the different land use / land cover classes in the research regions

class	land use/land cover type	description	PH_1	PH_2	PH_3	VN_1	VN_2	VN_3	VN_4
1	water bodies	lakes, rivers, ponds	x	x	x	x	x	x	x
2	ancient forest	old-growth forest (not reforested)			x		x	x	
3	forest	principally trees, also shrubs, bushes and storey			x		x	x	x
4	meadow/grassland	grass cover für grazing	x	x		x	x		
5	highly sealed surface	houses and other buildings, streets..	x	x	x	x	x	x	x
6	low sealed surface	e.g. unpaved roads, partially sealed surfaces	x	x	x	x	x	x	x
7	fruit plantations	fruit trees, banana plantations, coconut trees..	x	x		x	x	x	x
8	irrigated rice	permanently irrigated rice fields	x	x	x	x	x	x	x
9	vegetable plantation	e.g. potatoes, eggplant, peppers, pumpkins 	x	x	x	x	x	x	x
10	other agricultural land	agricultural land uses not covered by classes 7-9	x	x		x	x	x	x
11	leisure facilities	parks, camping and sports ground, golf courses..	x	x		x	x	x	
12	mineral extraction sites	mines, gravel pits		x		x	x	x	
13	wetland	bogs, marshes					x		
14	bare areas	bare rock, sand..			x	x	x	x	

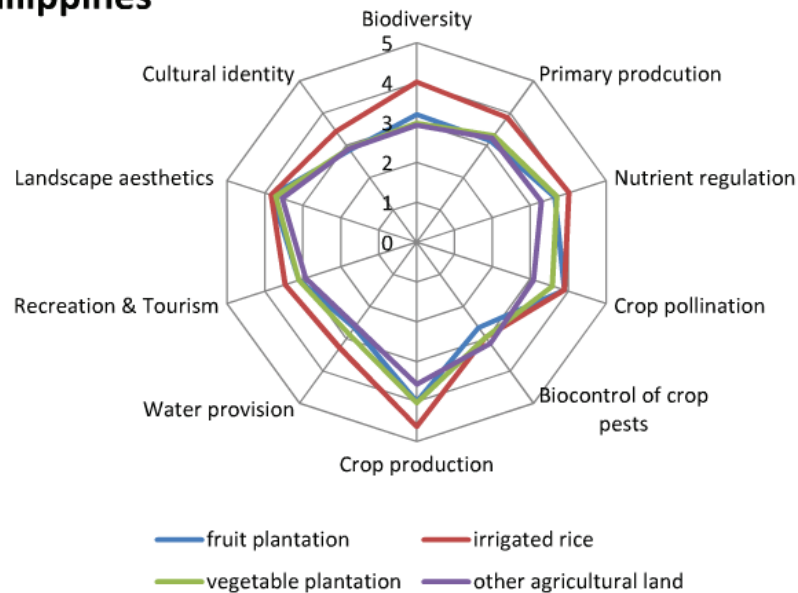
- Ancient forest only in rural areas of less intensive cultivated regions
- Water bodies, rice fields, vegetable plantations and sealed surfaces were relevant in any region
- No occurrence of wetlands

Valuation of irrigated rice



Valuation of agricultural land uses

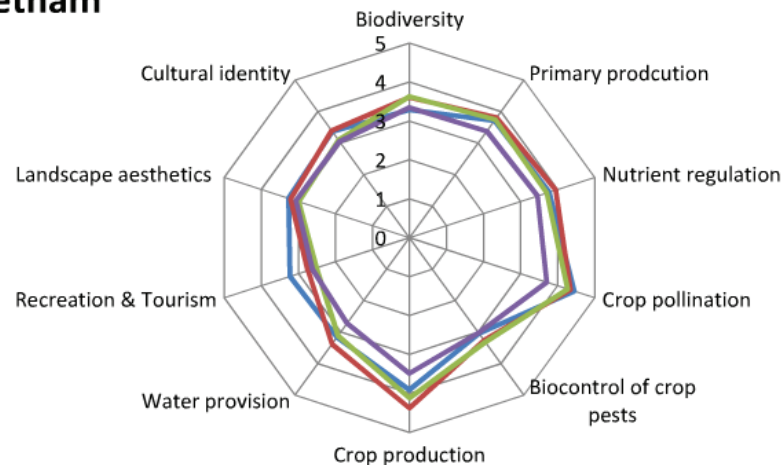
Philippines



Philippines

- Rice cropping systems get higher values than fruits/vegetable plantations for all ESF/ESS
- Biodiversity highest value in rice systems!
- No significant difference between fruit and vegetable plantations
- Landscape aesthetics as most valued cultural service

Vietnam



Vietnam

- Recreation and tourism less relevant than in the Philippines (exception: fruit plantations)
- Generally lower values for almost all ESS/ESF in rice cropping systems
- Highest rating for biodiversity in vegetable plantations

Ranking of the valued Functions and Services

Philippines

Rank	ESF/ESS
1	Water provision
2	Crop production
3	Primary Production
4	Nutrient regulation
4	Biocontrol of crop pests
5	Biodiversity
6	Crop pollination
7	Cultural identity
8	Recreation and tourism
9	Landscape aesthetics

Vietnam

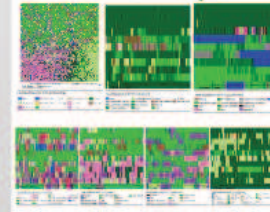
Rank	ESF/ESS
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4	Nutrient regulation
4	Biocontrol of crop pests
4	Water provision
5	Crop pollination
6	Cultural identity
7	Recreation and tourism
7	Landscape aesthetics

n=25

Land use / land cover classification

- Based on a blend of SPOT5 panchromatic and SPOT5 multispectral data
- Supervised classification with ERDAS Imagine software
- Not distinguishable due to technical reasons:
 - Forest & ancient forest
 - Sealed & industrial areas, leisure facilities
 - Bare soil & mineral extraction sites

LULC maps



Computing of Maps

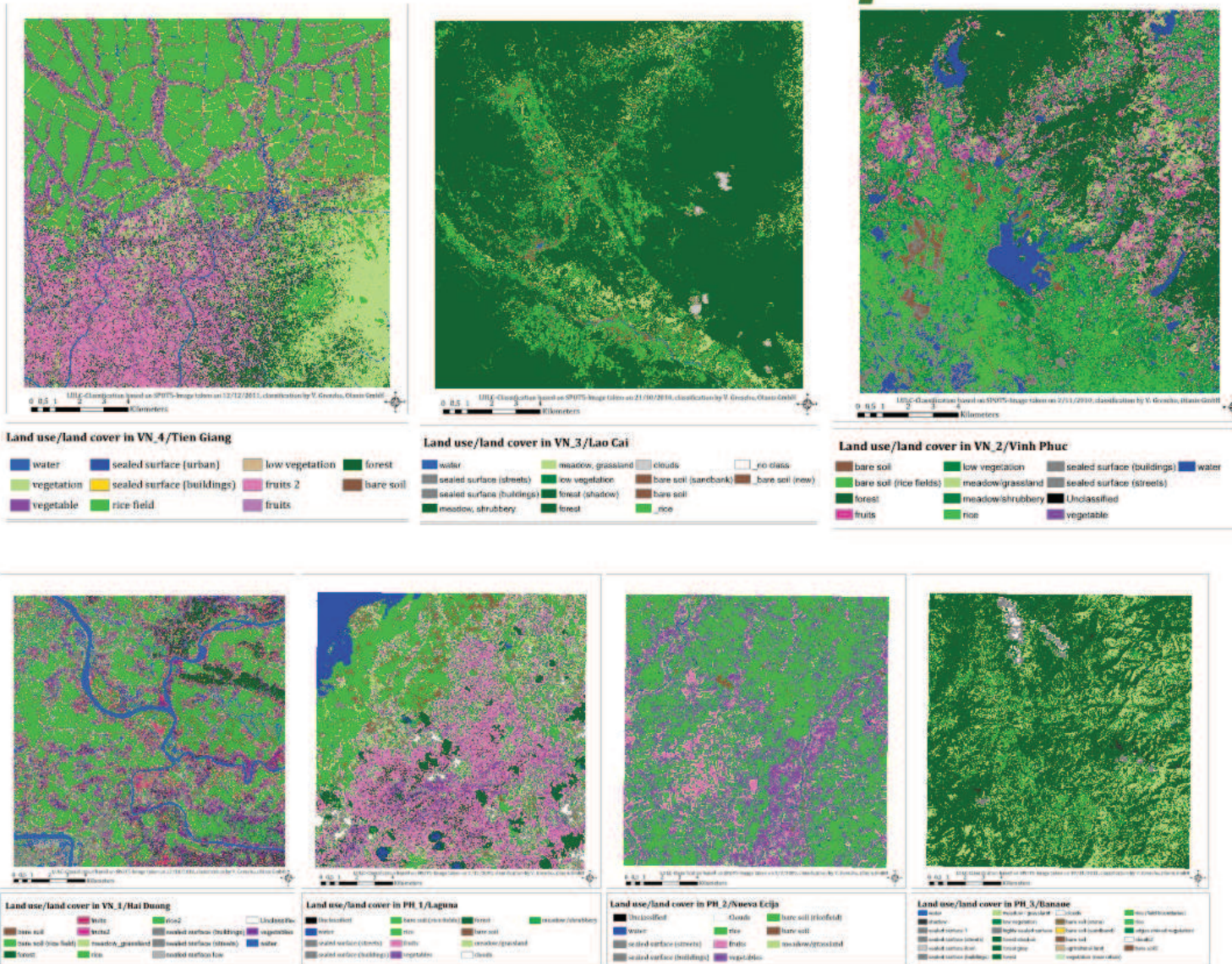
the ESF/ESS maps

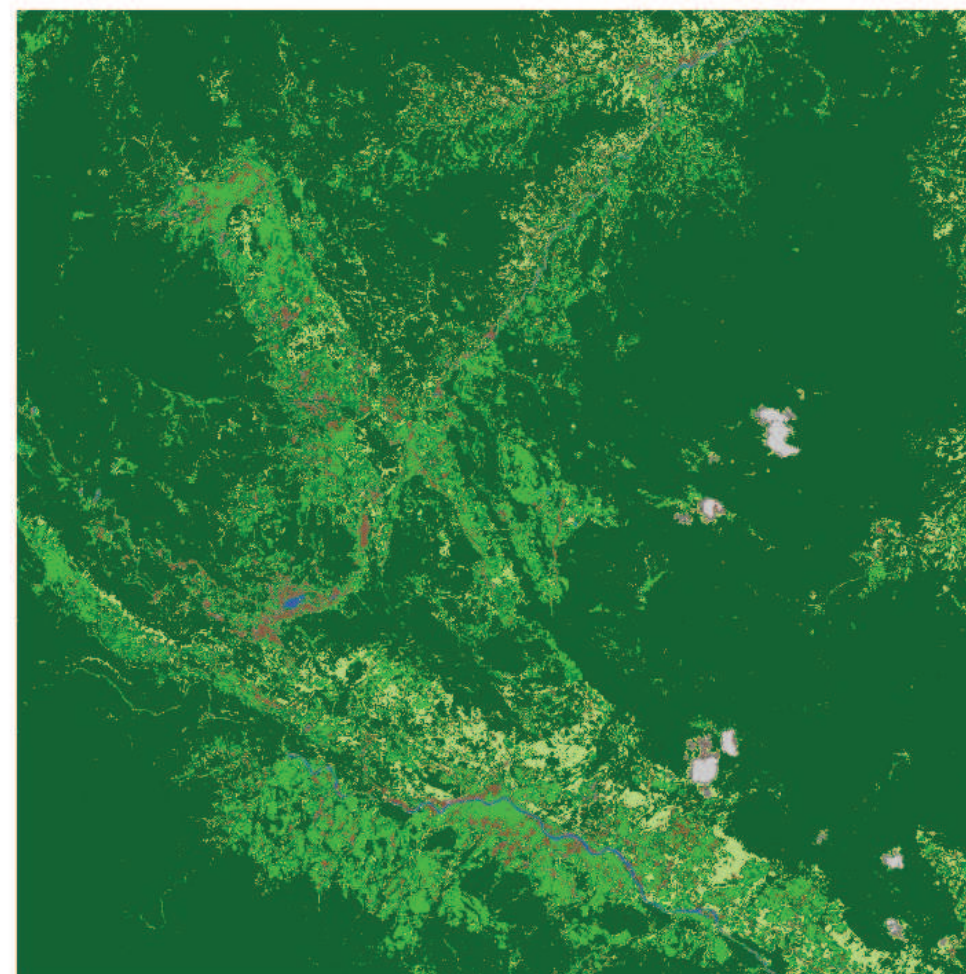


Land use / land cover classification

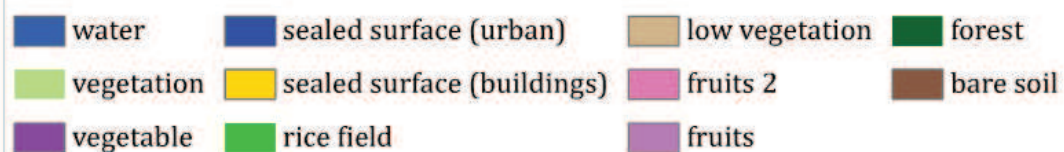
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LULC maps





Land use/land cover in VN_4/Tien Giang



Land use/land cover in VN_3/Lao Cai



the ESF/ESS maps

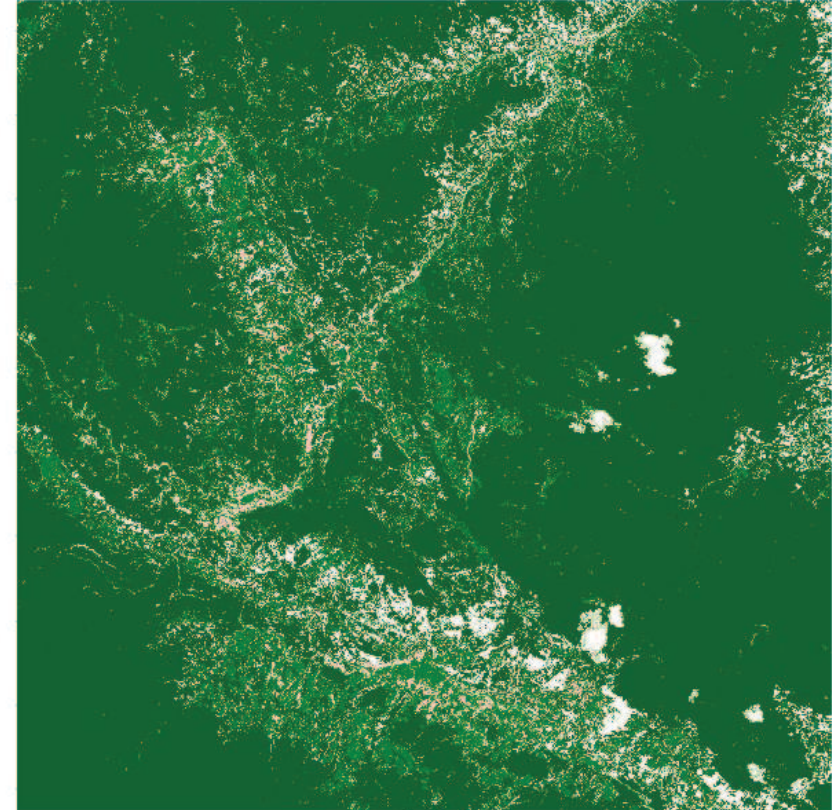


Biodiversity in VN_1/Hai Duong

Supply capacity of land use/land cover classes

- no capacity
- very low capacity
- low capacity
- medium capacity
- high capacity
- very high capacity
- no data

0 0,5 1 2 3 4 Kilometers
 LULC-Classification based on SPOT5-
 Image taken on 22/10/2010,
 classification by V. Grescho, Olanis GmbH
 Map compilation: Anja Müller, CAU Kiel,
 March 2013



Biodiversity in VN_3/Lao Cai

Supply capacity of land use/land cover classes

- no capacity
- very low capacity
- low capacity
- medium capacity
- high capacity
- very high capacity
- no data

0 0,5 1 2 3 4 Kilometers
 LULC-Classification based on SPOT5-
 Image taken on 21/10/2010,
 classification by V. Grescho, Olanis GmbH
 Map compilation: Anja Müller, CAU Kiel,
 March 2013



Nutrient regulation in VN_1/Hai Duong

Supply capacity of land use/land cover classes

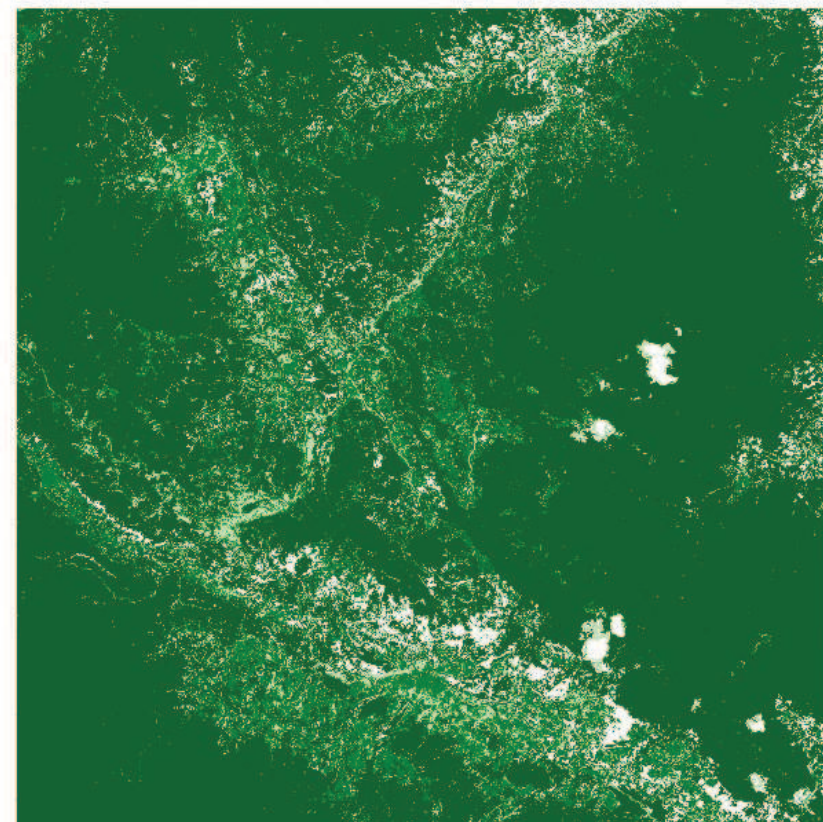
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- very low capacity
- low capacity
- medium capacity
- high capacity
- very high capacity

no data

0 0,5 1 2 3 4
Kilometers

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March 2013



Nutrient regulation in VN_3/Lao Cai

Supply capacity of land use/land cover classes

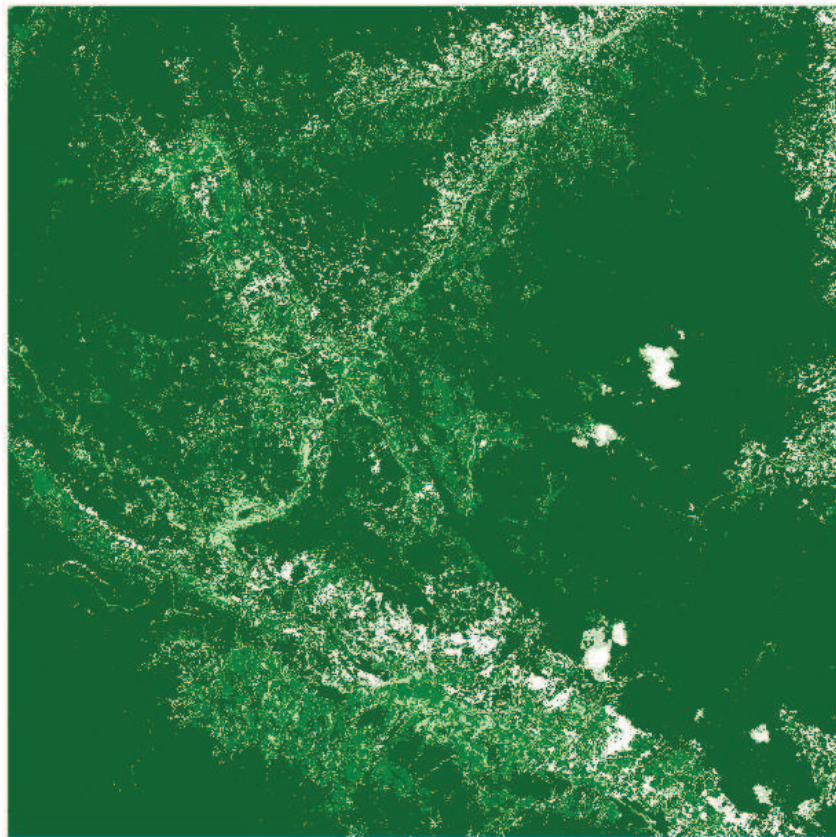
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no data

0 0,5 1 2 3 4
Kilometers


LULC-Classification based on SPOT5-
Image taken on 21/10/2010,
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March 2013



Cultural identity in VN_3/Lao Cai

**Supply capacity
of land use/
land cover
classes**

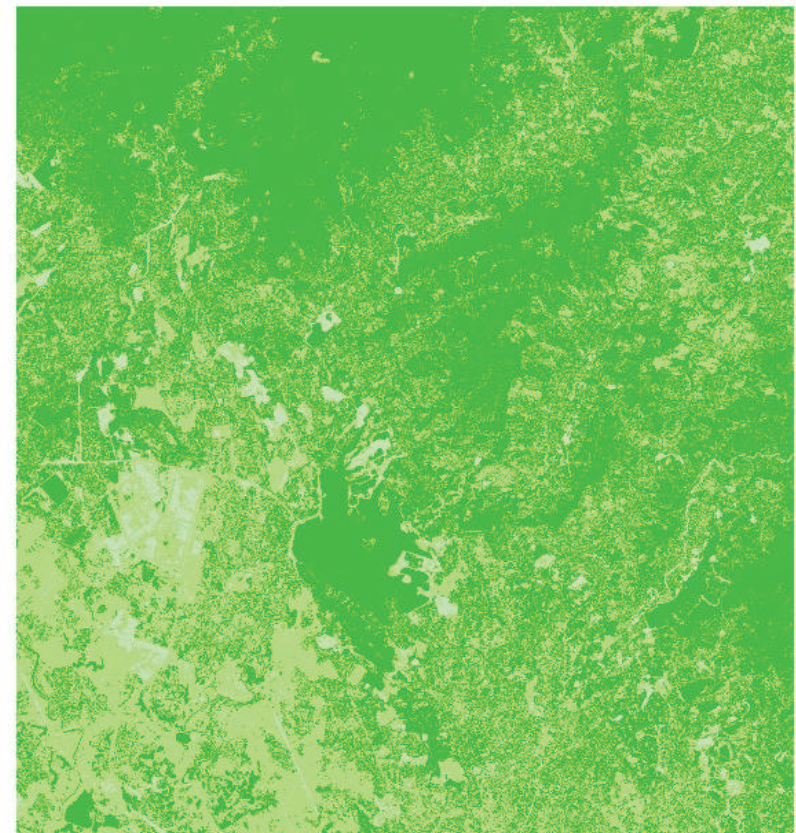
 no data

 no capacity
 very low capacity
 low capacity
 medium capacity
 high capacity
 very high capacity

0 1,25 2,5 5
Kilometer

LULC-Classification based on SPOT5-
Image taken on 21/10/2010,
classification by V. Grescho, Olanis GmbH

Map compilation: Anja Müller, CAU Kiel,
March 2013



Cultural identity in VN_2/Vinh Phuc

**Supply capacity
of land use/
land cover
classes**

 no data

 no capacity
 very low capacity
 low capacity
 medium capacity
 high capacity
 very high capacity

0 0,5 1 2 3 4
Kilometers

LULC-Classification based on SPOT5-
Image taken on 2/11/2010,
classification by V. Grescho, Olanis GmbH

Map compilation: Anja Müller, CAU Kiel,
March 2013



Crop production in PH_2/Nueva Ecija

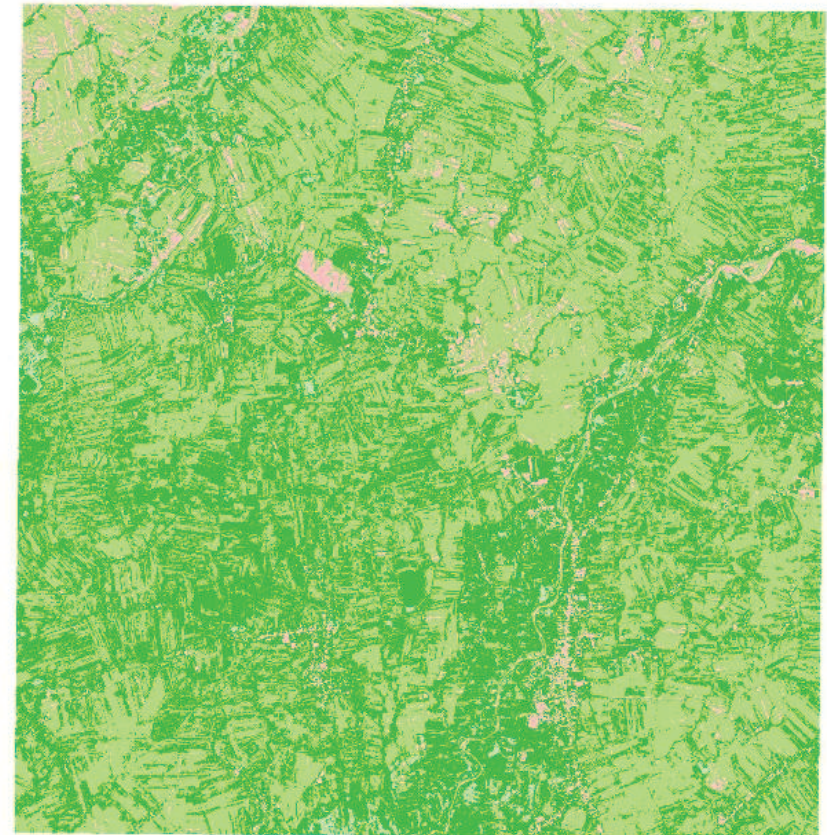
Supply capacity of land use/land cover classes

- no capacity
- very low capacity
- low capacity
- medium capacity
- high capacity
- very high capacity
- no data

0 0,5 1 2 3 4
Kilometers

LULC-Classification based on SPOT5-
Image taken on 3/2/2009, classification
by V. Grescho, Olanis GmbH

Map compilation: Anja Müller, CAU Kiel,
March 2013



Biocontrol of crop pests in PH_2/Nueva Ecija

Supply capacity of land use/land cover classes

- no capacity
- very low capacity
- low capacity
- medium capacity
- high capacity
- very high capacity
- no data

0 0,5 1 2 3 4
Kilometers

LULC-Classification based on SPOT5-
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Uncertainties

- Statistical significance - amount of collected data and representativeness of participants
- Information loss due to technical limitations
- Expert surveys

[No professional experience - uncertainty about degree of understanding from participants]
[Technical limitations - unknown influence of one on other participants]
[Influence of monetary considerations on given answers to their knowledge]
[Comparability of the data across any other individuals, time or previous knowledge]



- Statistical significance - amount of collected data and representativeness of participants
- Information loss due to technical limitations
- Expert surveys

- No professional interpreter - insecurity about degree of understanding from participants
- Hierarchical structures - assumed influence of one on other participants
- Influence of mentality - unwillingness to give low values to "their" landscapes
- Comprehensibility of the ESS-concept - only short introduction, often no previous knowledge



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Conclusion + Outlook

conclusion

- Combination of quantitative (LULC) and qualitative (expert values) data gives a comprehensive impression about current states in varying rice cropping systems and related production intensities.
- Overall significantly higher capacity of landscapes to provide Ecosystem Functions and Services in less intensive cultivated rice cropping systems
- Expressiveness of maps should be increased by integration of further data from measurements and/or modelling

outlook

- integration of data from comprehensive field measurements and modelling results collected/produced in the course of LEGATO project
 - increasing the expressiveness of maps
- develop methods to improve comparability of results from different regions



conclusion

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→ increasing the expressiveness of maps

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Thank you for listening!

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