Department of Ecosystems and
Environmental Informatics

Brandenburgische
Technische Universität
Cottbus

Establishing Potential Payment for Intangible Ecosystem Services: The Case of UNESCO Biosphere Reserve Spreewald

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Introduction

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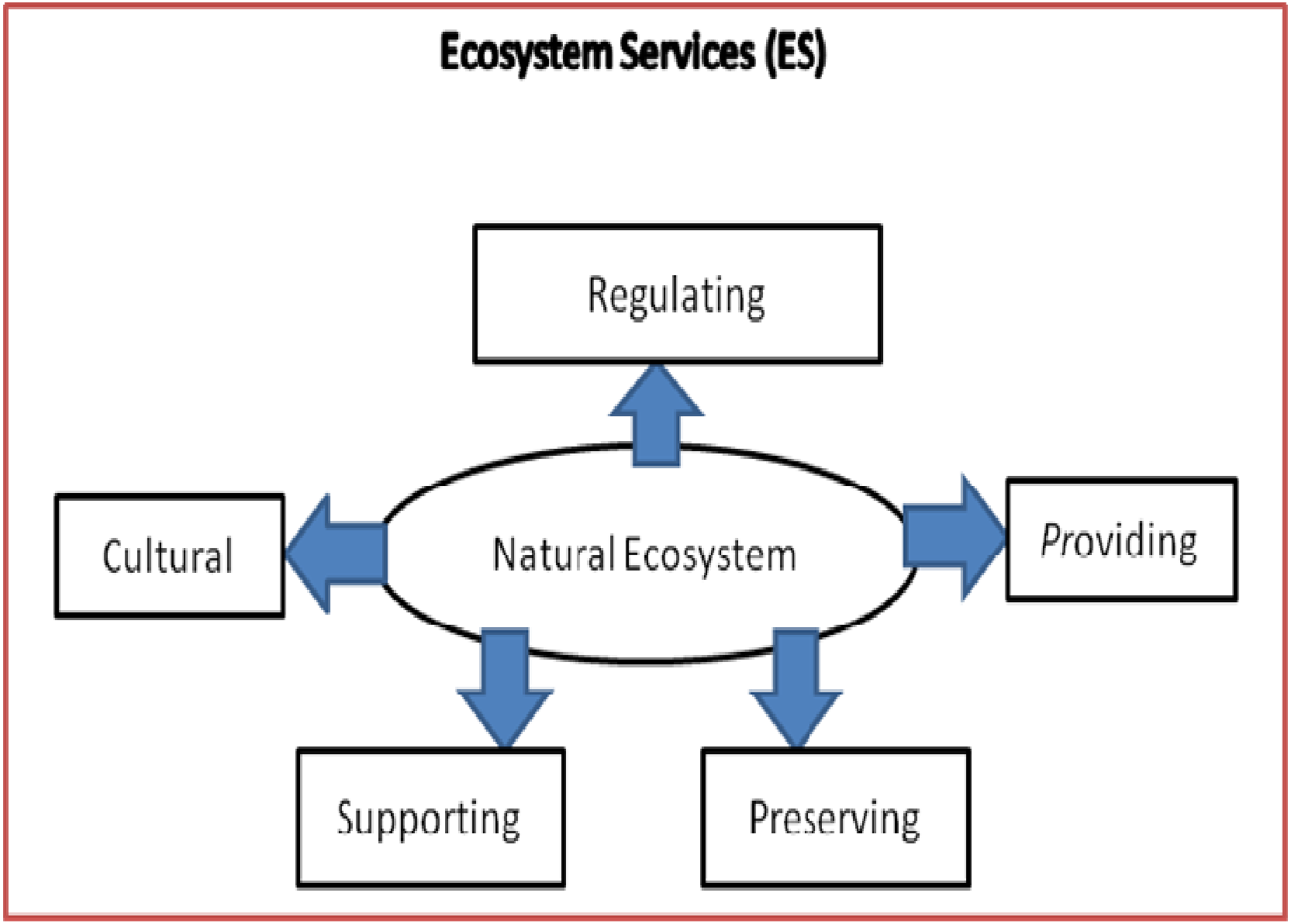
- Different Stakeholders increasing willing to know the monetary estimate of the value of ES base on different interests
- But challenging to find the monetary value of natural systems due to their complexity and characteristics
- Deriving potential demand and supply for ES within multi-actor activities at a particular parcel of land within a particular time period
- One can derive potential PES based on established market Institutions


Ecosystem Services (ES)
Regulating
Cultural
Natural Ecosystem
Providing
Supporting
Preserving

Main Categories of ES	**Types of ES**	**Components for ES**	**Activities (Balance, Improve and Deficit of ES)**
Providing	Food, fibre, wood, energy and water	Plant (Tree, grass and crops) and animal species, farmland and Forestland, water balance, abandonment of pastoral system, Herbs (pharmaceutics), Herbs, Fruits, Vegetables	Irrigation extraction, evapo-transpiration runoff and drainage, grazing and cultivation, tree removal without replanting, animal breeding, Stock feeding, Modification of cultivation practices
Regulating	Water regulation (surface and ground), Control of pest, diseases, climate and air quality	Water quality, filtering water, temperature reduction, pest, diseases, Carbon Sequestration, filtering dust particles air, pollution removal	Pollution by nitrates and pesticides, salinity, acidity and nutrients (P,N and others),production of renewable energy from agro-forestry, greenhouse gas emission and ammonia from agro-forestry, avoidance of emission

Support	Nutrient cycle and crop pollination	Maintenance of soil quality, Nutrients balances, bees population, soil loss, nutrient	Extension of bee, organic farming, ecological farming, feed, fertilizer, burning, energy and acquisition of land, weed, animals pests, release of land, areas of risk of soil erosion, cultivation,
Preserving	Maintenance of biological and genetic diversity against uncertainty	Storm mitigation, biological refugia, noise reduction, flood control, richness/abundance of species	Deforestation, land fragmentation, conservation banking, hunting
Cultural	Recreation and spiritual	Aesthetic, monuments sanctuaries, natural parks, secret places, Inspirations, Eco-tourism	Tourist activities, cultural activities, transport, birthplace for various traditional performances, cultural heritage

Methodology

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- The method is in two folds a modelling framework with stochastic coloured Petri net and a data sampling framework
- Petri net is a graphical and mathematical technique for modelling flow system and have been used in many fields such like fresh water ecology, molecular biology, business, transport and logistic etc.
- It can be used for continuous, discrete, stochastic and hybrid modelling and simulation
- That is continuous, time, stochastic, hybrid, place /transition and high level nets like colour Petri net, which may be discrete, continuous or stochastic and even hybrid Petri nets depending on the goal

Petri Net Modelling Framework

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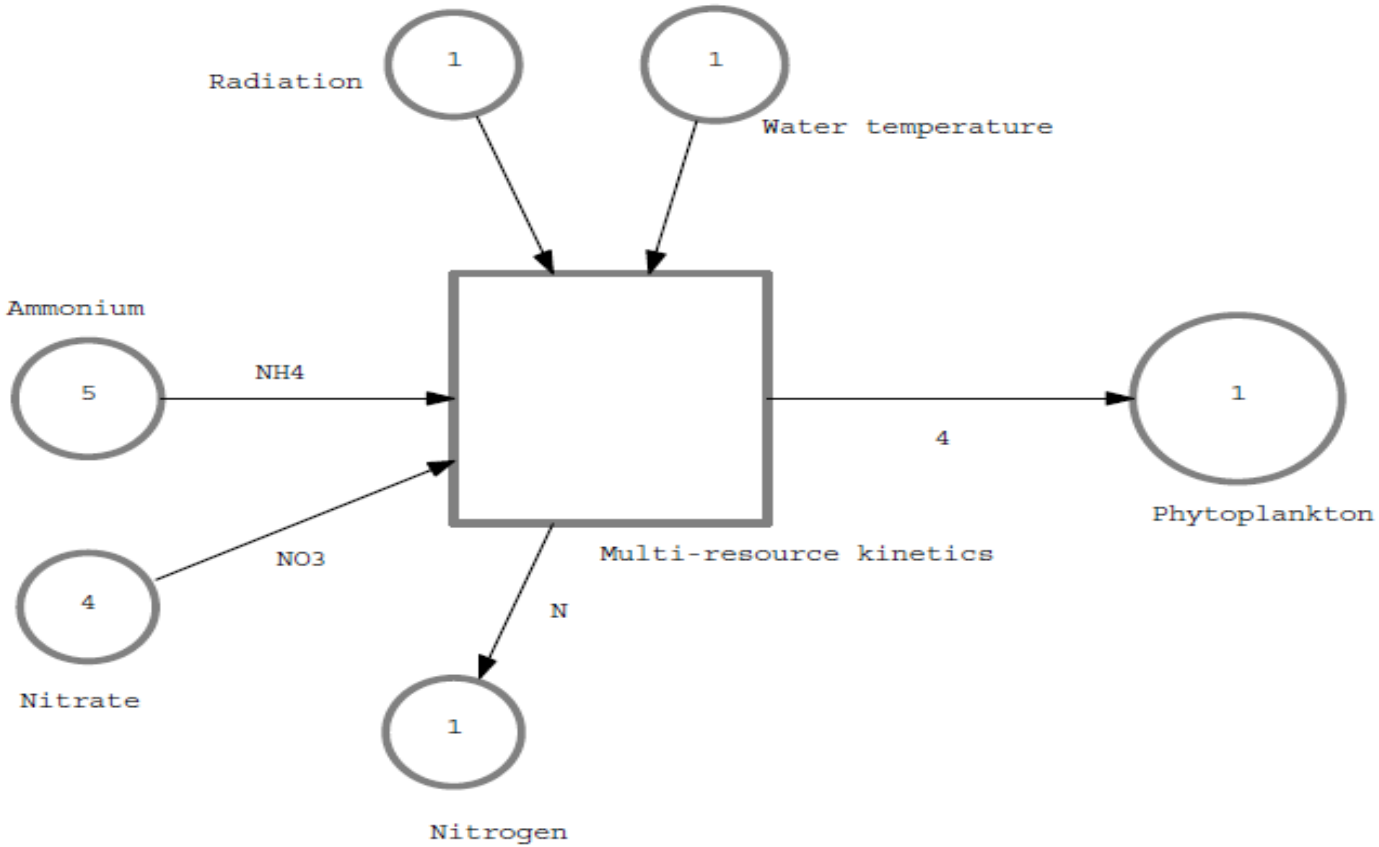

Petri Net of an ecological process for one photo phase of Phytoplankton

Conceptual Model Building with Petri Nets

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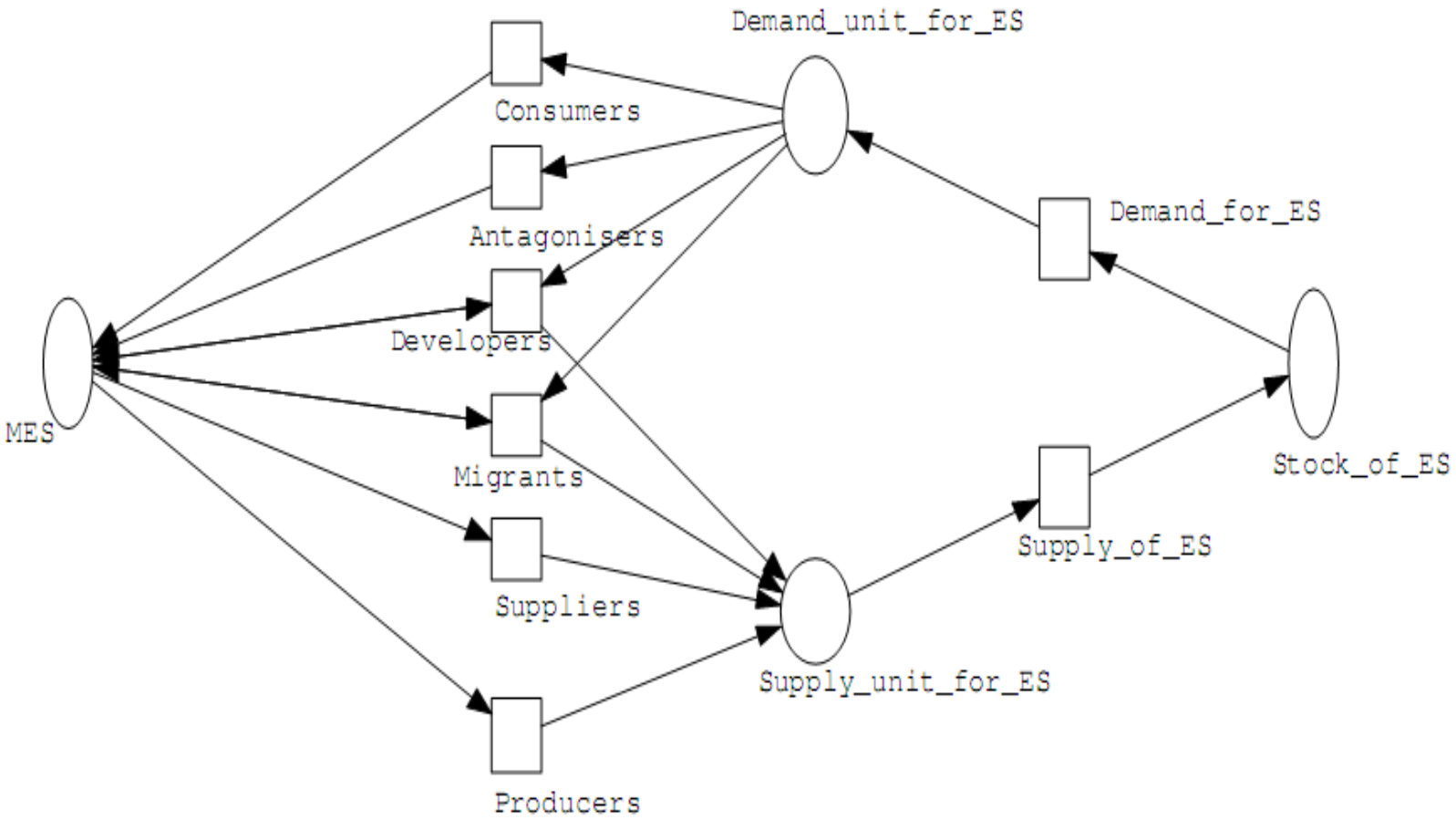

Description of relationships

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- If the Petri net is defined as N and described as a triple (S, T, W)
- S= { s1, s2, s3, s4}
- T= {t1, t2, t3, t4, t5, t6, t7, t8}
- W- Flow rate
- Markings: Comp = {Comp1, Comp2, Comp3}
- Tokens: ES= {ES1, ES2, …, ES5}

Definition of Coloursets

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- The different markings and their set of tokens are differentiated by colours
- Markings: Comp = {Comp1, Comp2, Comp3}
- Tokens: ES= {ES1, ES2, …, ES5}
- Coloursets:

Comp1= {Comp1 ES1, Comp1 ES2, …, Comp1ES5}
Comp2= {Comp2 ES1, Comp2 ES2, …, Comp2 ES5}
Comp3= {Comp3 ES1, Comp3 ES2, …, Comp3 ES5}

Execution

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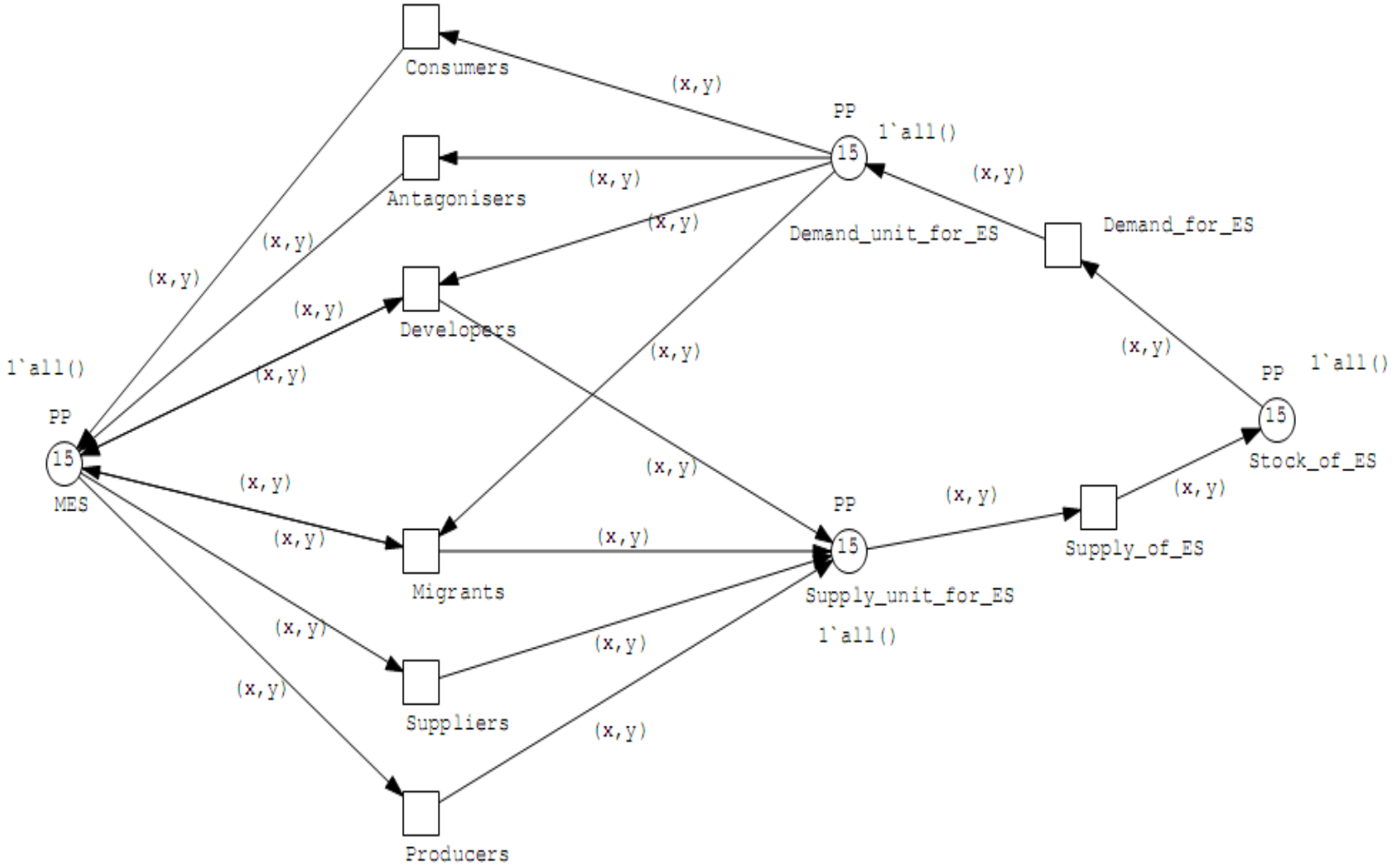

Institutional Capacity

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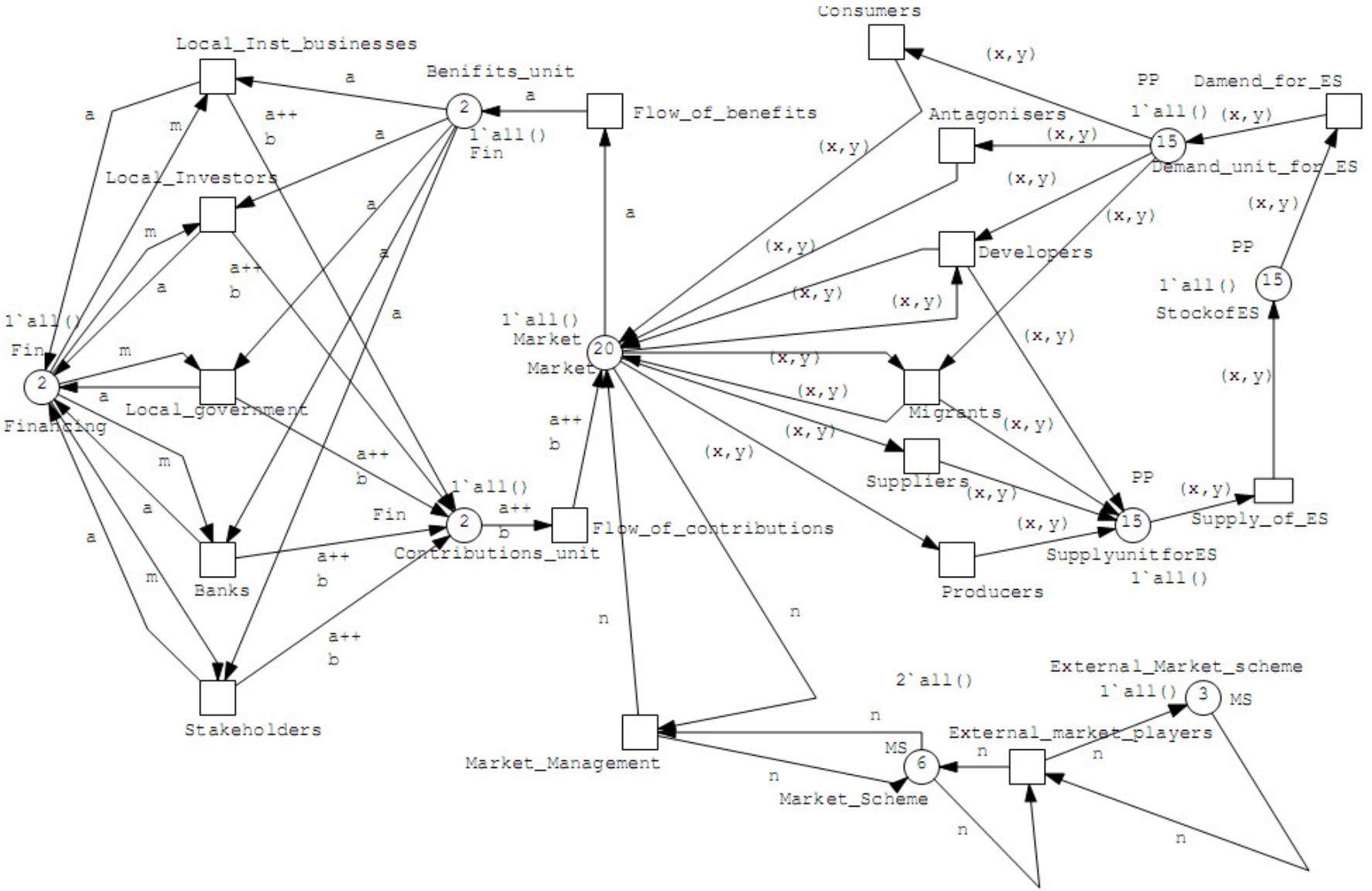

Data Sampling Strategy

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- Data Collection is based on cross-sectional field observation in the Spreewald biosphere reserve
- The data source comprises of landscape components associated with ES, activities that lead to their balance, improvement and deficit and indicators
- They are quantified by qualitative value judgement based on ranking them to a scale of 0 to 5
- 0 (relevant capacity), 1 (low relevant capacity), 2 (relevant capacity), 3 (medium relevant capacity), 4 (high relevant capacity) and 5 (very high relevant capacity)

Data Sampling Strategy

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- **Preparatory Set Up for Data Collection**
- **Data Collection**
- **Data Aggregation Procedures**
  - $(\Sigma\ n1x1 + n2x2\ ,\ \ldots) \div (\Sigma n1 + n2\ ,\ \ldots)$
- **Quality Assurance of Data**
  - Estimators: Unbias and Consistency

Data Conversion

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Ranking Scale	Conversion % (1500)	Meaning
0	0	No relevant capacity
1	20 (300)	Low relevant capacity
2	40 (600)	Relevant capacity
3	60 (900)	Medium relevant capacity
4	80 (1200)	High relevant capacity
5	100 (1500)	Very high relevant capacity

Case of UNESCO Biosphere Reserve Spreewald

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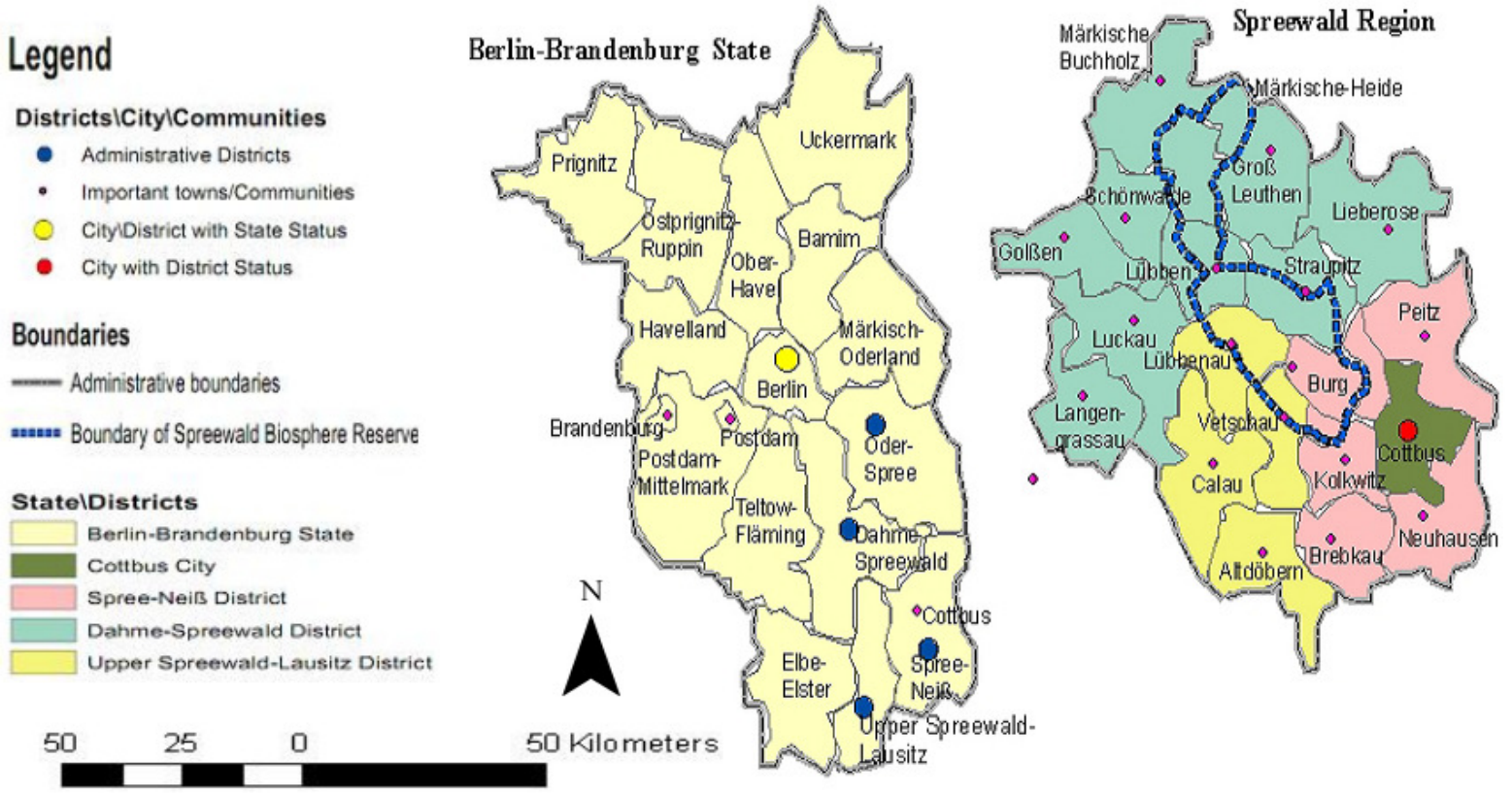

Results

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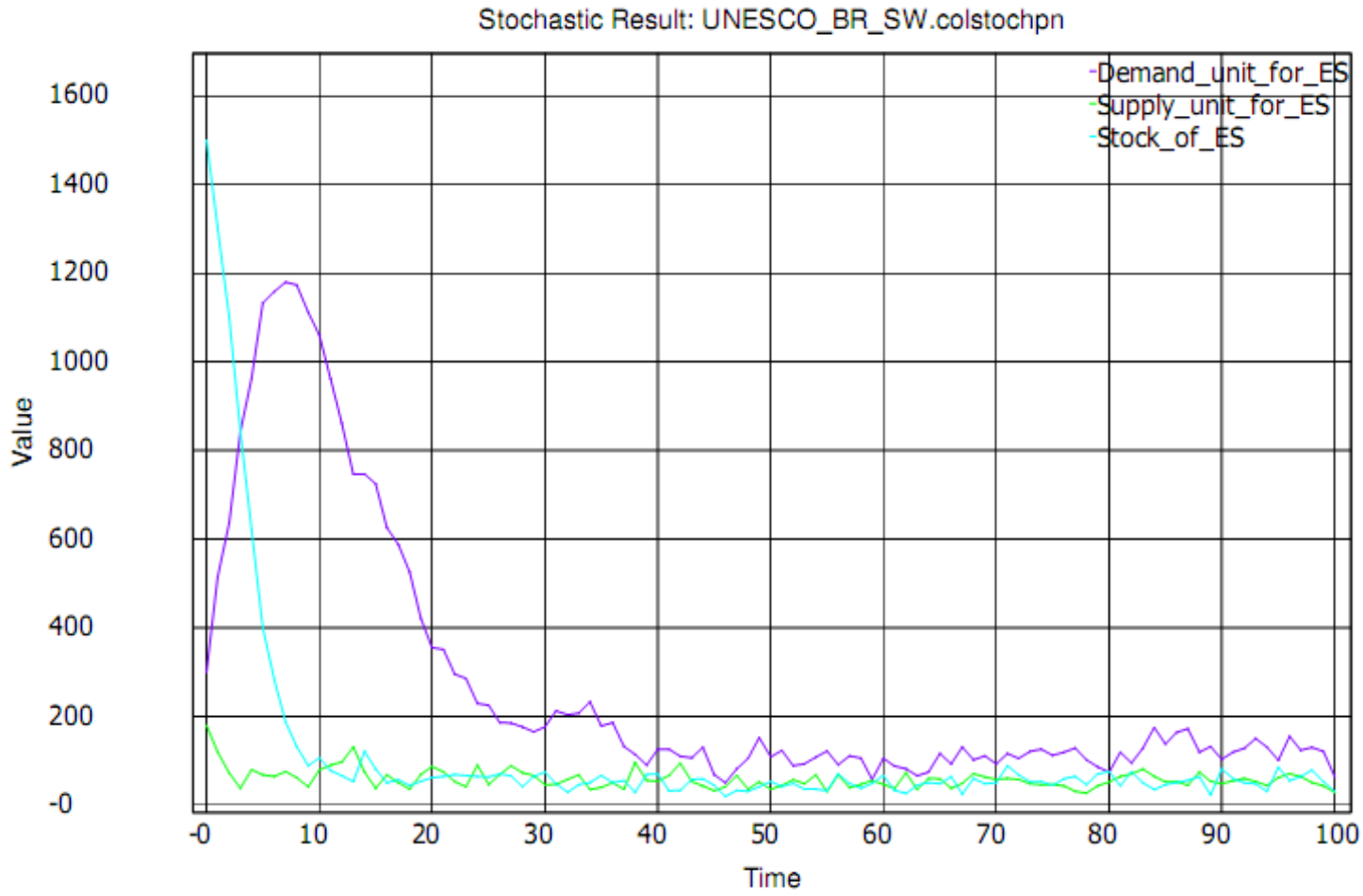

Results

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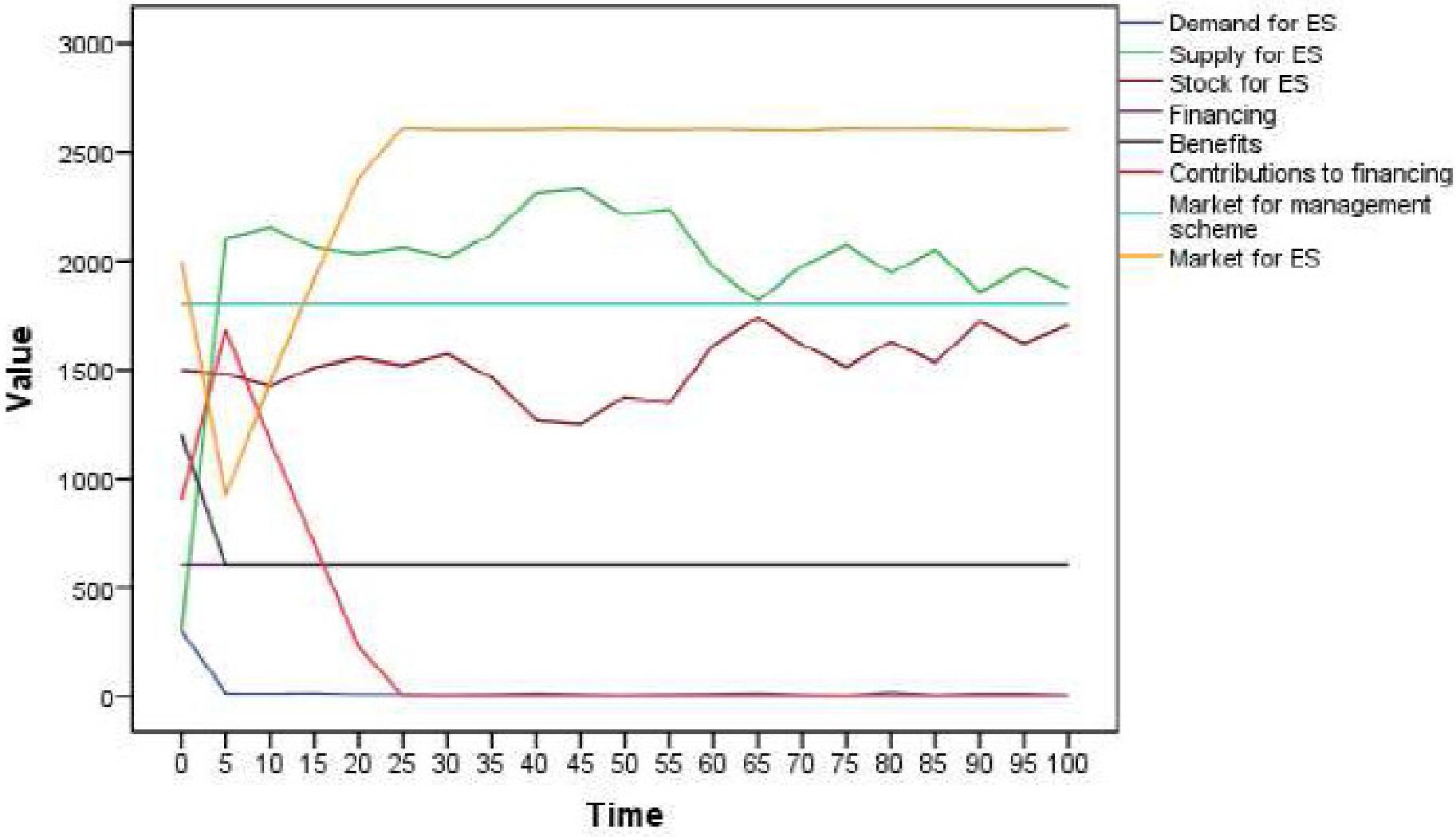

Discussions

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Conclusions

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- Markets for ecosystem services need to be encourage by increasing measures for preservation of ecosystem services requiring institutional arrangements
- However, there are current discussion on the legal system on pools for balancing landscape problems, this may favour the growth of MES and community-based financial participation
- Therefore data mangement systems are essential for analysis and structuring strategic measures for preserving ES that can favour the analysis of potential for MES to support institutional frameworks
- This has been realised in the modelling and data sampling framework with Petri nets. Therefore Petri net is good tool for modelling ES that it use needs to encourage in this araea of PES research

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