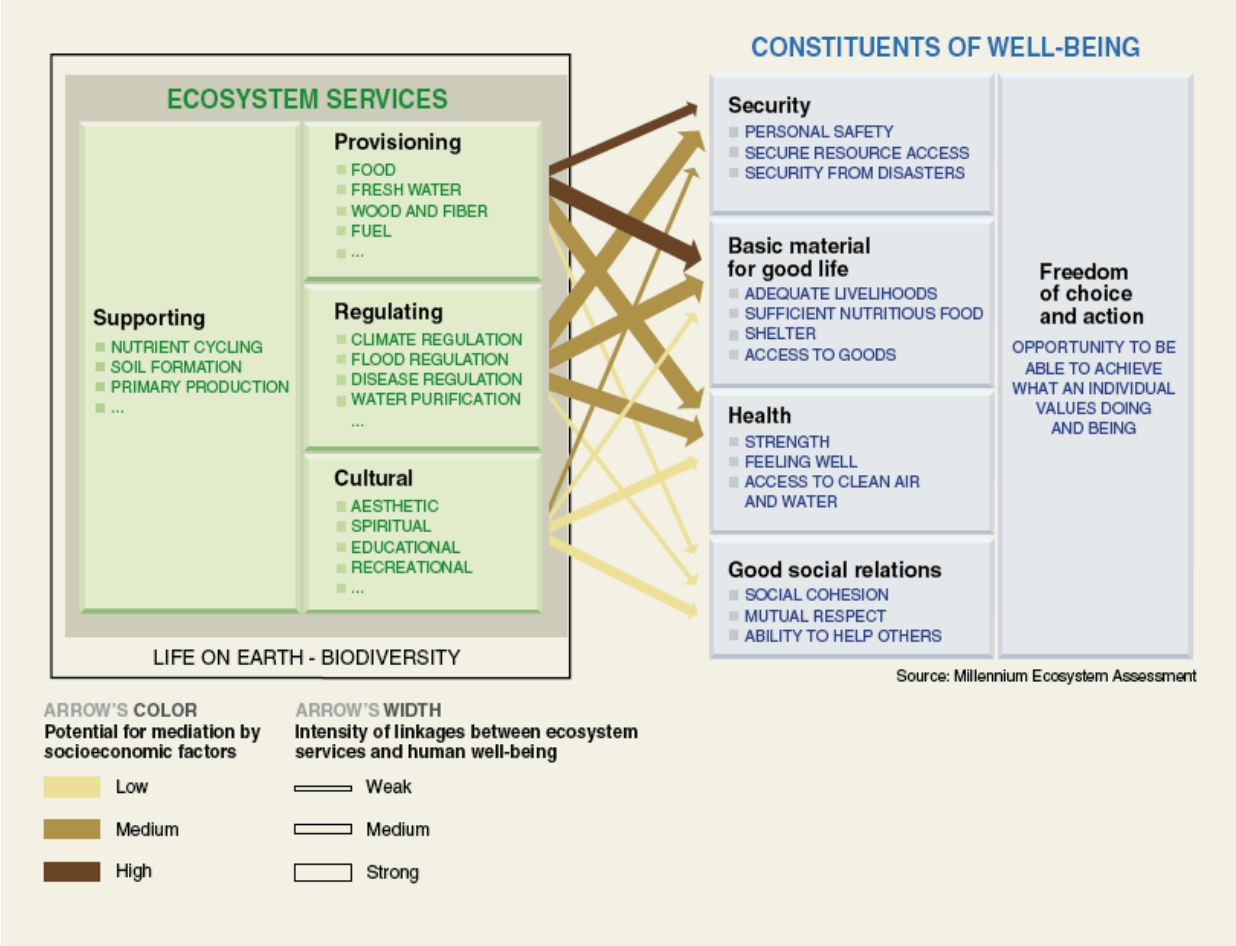
The relationship between intragenerational and intergenerational justice in the use of ecosystems and their services

Stefan Baumgärtner, Stefanie Sievers-Glotzbach and Martin F. Quaas

Fourth International Conference on Degrowth for Ecological Sustainability and Social Equity

September 3rd 2014

Motivation


ECOSYSTEM SERVICES
Provisioning
FOOD
FRESH WATER
WOOD AND FIBER
FUEL
...
Supporting
NUTRIENT CYCLING
SOIL FORMATION
PRIMARY PRODUCTION
...
Regulating
CLIMATE REGULATION
FLOOD REGULATION
DISEASE REGULATION
WATER PURIFICATION
...
Cultural
AESTHETIC
SPIRITUAL
EDUCATIONAL
RECREATIONAL
...
LIFE ON EARTH - BIODIVERSITY
CONSTITUENTS OF WELL-BEING
Security
PERSONAL SAFETY
SECURE RESOURCE ACCESS
SECURITY FROM DISASTERS
Basic material for good life
ADEQUATE LIVELIHOODS
SUFFICIENT NUTRITIOUS FOOD
SHELTER
ACCESS TO GOODS
Health
STRENGTH
FEELING WELL
ACCESS TO CLEAN AIR AND WATER
Good social relations
SOCIAL COHESION
MUTUAL RESPECT
ABILITY TO HELP OTHERS
Freedom of choice and action
OPPORTUNITY TO BE ABLE TO ACHIEVE WHAT AN INDIVIDUAL VALUES DOING AND BEING
Source: Millennium Ecosystem Assessment
ARROW'S COLOR
Potential for mediation by socioeconomic factors
Low
Medium
High
ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being
Weak
Medium
Strong

Motivation

Ecological crises as a twofold social crises

Harmful effects of diminishing ecosystem services

- Negative externalities
- Loss of access to natural resources

The pattern of „winners“ and „loosers“ associated with ecosystem changes, and particular the impacts of ecosystem changes on poor people, women, and indigenous peoples, has not been adequately taken into account in management decisions.

(MEA 2005: 62)

+ impacts on future generations !

Motivation

- **Two objectives of justice** regarding the conservation and use of ecosystems and its services (MEA 2005, TEEB 2010, UNEP 2012):
  - *Intra*generational justice
  - *Inter*generational justice

  ➢ (Possible) **conflicts** between the objectives of justice in the design and implementation of sustainability policy

- Research gap: simultaneous modeling of intragenerational and intergenerational problems in renewable resource use

Original contribution

- **Primary normative orientation: Sustainability**
  - Intragenerational environmental justice
  - Intergenerational environmental justice
- Model depicts important **differences in ecosystem services**
  - Substitutability (in utility between provisioning, regulating and cultural services)
  - Consumptivity of (natural capital)
  - (Intragenerational) rivalry in use
  - Excludability from use

Motivation regarding degrowth

Why is a steady-state economy both necessary and desirable? (Daly 1977)

Motivation regarding degrowth

How may determinants of degrowth impact on intragenerational and intergenerational justice and the occurrence of justice conflicts?

- Intrinsic growth rate/ regeneration rate of the renewable resource
- Population development
- Technological development in harvesting
- Constraints on intragenerational distribution of resource utilization rights
- Constraints on intergenerational distribution of resource utilization rights

Outline

1. Conceptual foundations
2. Model description
3. Model results
4. Summary and discussion

1. Conceptual foundations

Justice in the use of ecosystem services:

- Ecosystem services as objects of distribution
  - The instruments used to fulfill legitimate claims for justice
- *Access rights* to ecosystem services
  - Normative background of a concrete distribution
  - Can actually be distributed
- *Distribution* of ecosystem services
  - Intragenerational distribution relates to the access to a specific quantity or quality of ecosystem services.
  - Intergenerational distribution relates to the passing on of (critical) ecosystem funds.

(Sievers-Glotzbach, S. 2013. Ecosystem services and distributive justice. Considering access rights to ecosystem services in theories of distributive justice. *Ethics, Policy & Environment,16 (2), 162-176.)*

1. Conceptual foundations

Justice in the use of ecosystem services:

What conception(s) of justice can adequately address the justice issues linked to the use of ecosystem services?

- Instrument of justice: „distribution“ of access rights to ecosystem services
- Community of justice: all humans of present and future generations
- **Principle of environmental justice**:
  Inequalities in the distribution of access rights to all vital ecosystem services are to be to the greatest benefit of the least-advantaged members of the present and actual future generations.

(Sievers-Glotzbach, S. 2013. Ecosystem services and distributive justice. Considering access rights to ecosystem services in theories of distributive justice. *Ethics, Policy & Environment,16 (2), 162-176.)*

1. Conceptual foundations

Justice Relationship:

Three hypotheses about the relationship between intragenerational and intergenerational environmental justice:

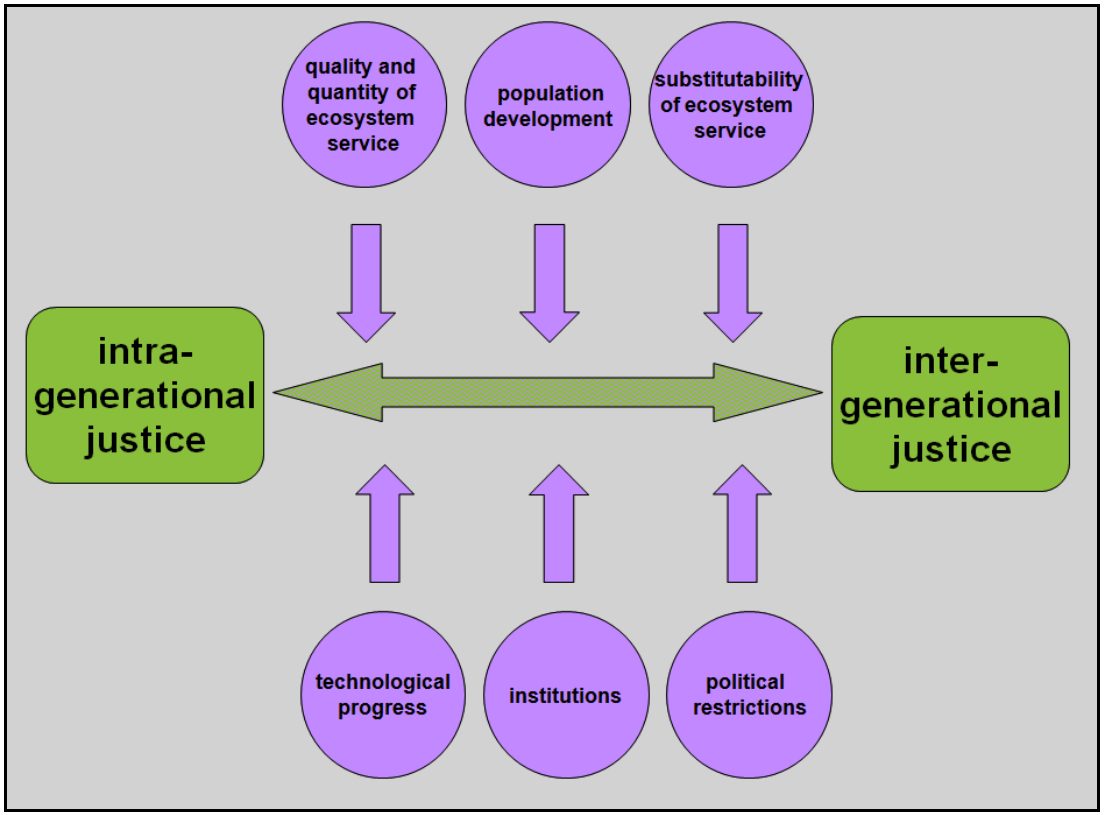
- Hypothesis 1: **Independency**
- Hypothesis 2: **Facilitation („win-win“)**
- Hypothesis 3: **Rivalry („trade-off“)**

(Glotzbach, S. and S. Baumgärtner 2012. The relationship between intragenerational and intergenerational ecological justice. *Environmental Values*, 21(3), 331–355)

1. Conceptual foundations

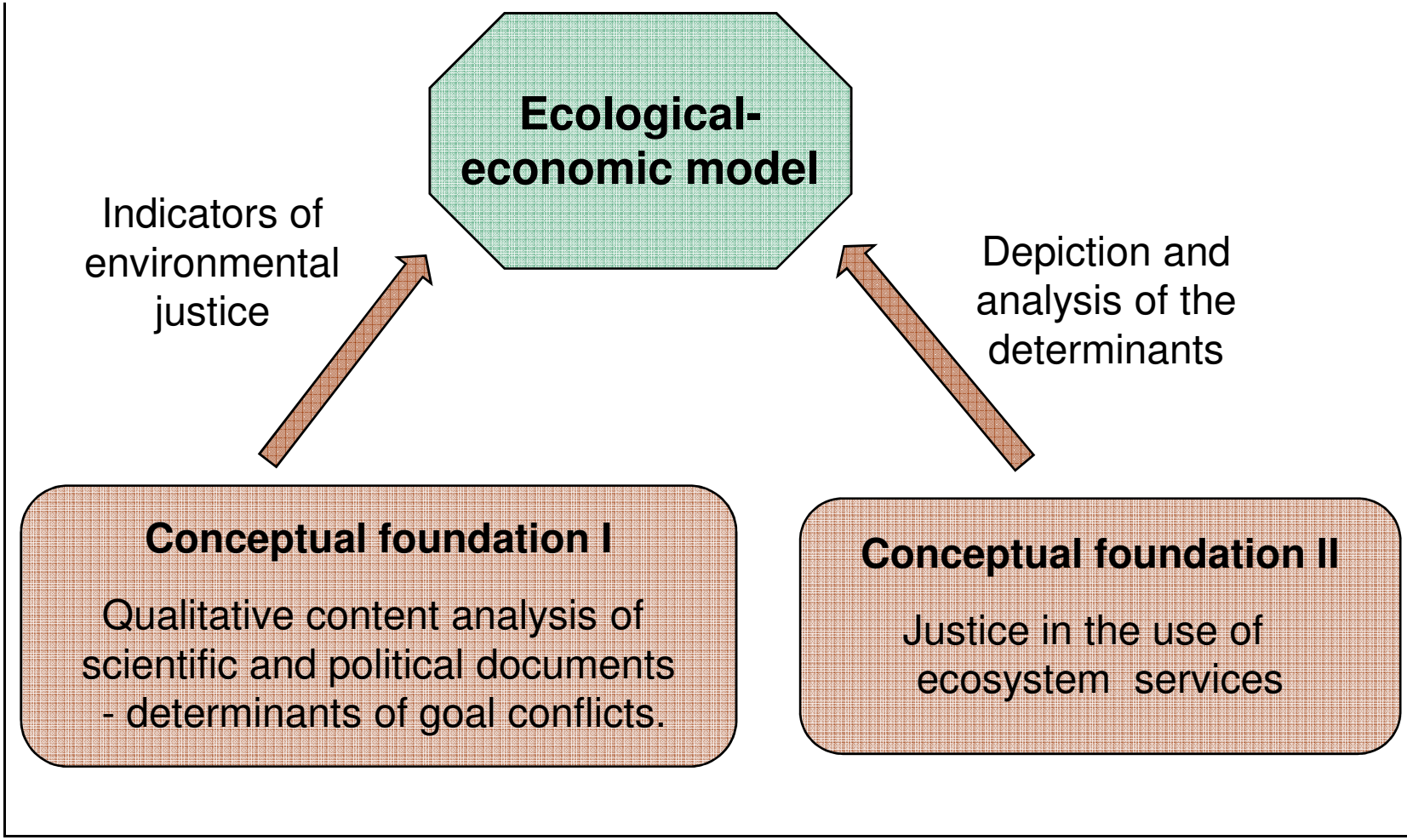
Justice Relationship:

Determinants of the justice relationship



(Glotzbach, S. and S. Baumgärtner 2012. The relationship between intragenerational and intergenerational ecological justice. *Environmental Values*, 21(3), 331–355)

1. Conceptual foundations



2. Model description

Agents and time structure:

- Two time intervals $t = 1,2$
- Two non-overlapping generations:
  - Generation 1 lives at time $t = 1$ and comprises two individuals *A* and *B*
  - Generation 2 lives at time $t = 2$ and comprises 2 n identical individuals *C* where $n > 0$ is the population growth rate

2. Model description

Goods and preferences:

- 4 goods: manufactured consumption good *Y*, renewable resource *R*, consumptive ecosystem service *H*, non-consumptive ecosystem service *S*

Utility function:

- $$U^i = U\left(Y^i, H^i, S^i\right) = \left[(1-\alpha)\left(Y^i\right)^{\frac{\sigma-1}{\sigma}} + \alpha\left(ES^i\right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \qquad (10)$$

with $$ES^i = \left[\beta\left(H^i\right)^{\frac{\theta-1}{\theta}} + (1-\beta)\left(S^i\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

$$\left(i = A, B, C;\ \theta > 0;\ \sigma > 0; 0 < \alpha < 1; 0 < \beta < 1\right)$$

- σ : Elasticity of substitution between Y^i and utility from aggregate ecosystem service consumption
- θ : Elasticity of substitution between H^i and S^i

2. Model description

Ecosystem and human production:

- Total endowment with the **manufactured consumption good** in *t* =*1*: Y_1
- Each individual *i* =*A,B,C* consumes an equal share:

$$Y^i = \frac{Y_1}{2} \quad \text{for } i=A,B \qquad (1)$$

$$Y^C = \frac{\mu\, Y_1}{2\, n} \qquad (2)$$

where $\mu > 0$ is the rate of autonomous technical progress in the manufactoring sector.

2. Model description

Ecosystem and human production:

- Total endowment with the **renewable resource stock** in $t=1$: R_1
- Intrinsic resource growth rate $\omega > 0$
- Individual $i = A,B$ possesses utilization rights to an amount $R^i \geq 0$ and harvests an amount H^i of the **consumptive ecosystem service** by means of a linear harvest technology subject to

$$R^A + R^B \leq R_1 \quad (3); \quad 0 \leq H^i \leq R^i \quad (4)$$

- Individual C possesses utilization rights to an amount $R^C \geq 0$ and harvests an amount H^C of the consumptive ecosystem service by means of the linear harvest technology subject to

$$R_2 = \omega\left(R_1 - H^A - H^B\right) \quad (6); \quad R^C \leq \frac{R_2}{2n} \quad (7); \quad 0 \leq H^C \leq \gamma R^C \quad (8)$$

where $\gamma > 0$ is the rate of autonomous technical progress in the harvest technology.

2. Model description

Ecosystem and human production:

Production of **Ecosystem service *S*** from the resource stock:

- where $\nu \in \{0,1\}$ denotes the degree of rivalry/ excludability of *S*

  $\nu = 1$: *S* is a pure private good

  $\nu = 0$: *S* is a pure public good

$$S^i = R^i - H^i + (1-\nu)\left(R_1 - R^i - H^j\right) \quad \text{for} \quad i = A,B\,;\; j \neq i\,. \tag{5}$$

$$S^i = R^i - H^i \qquad \text{for} \quad \nu = 1$$

$$S^i = R_1 - \left(H^A + H^B\right) \quad \text{for} \quad \nu = 0$$

$$S^C = R^C - \frac{H^C}{\gamma} + (1-\nu)\left(R_2 - R^C - (2n-1)\frac{H^C}{\gamma}\right) \tag{9}$$

$$S^C = R^C - H^C/\gamma \qquad \text{for} \quad \nu = 1$$

$$S^C = R_2 - 2\,n\,H^C/\gamma \quad \text{for} \quad \nu = 0$$

2. Model description

Agent's behaviour:

Individual $i = A,B,C$ chooses the levels of H^i and S^i so as to maximize his individual utility U^i subject to ecological, technological and institutional feasibility:

$$\max_{H^i, S^i} U^i = U\left(Y^i, H^i, S^i\right) \quad \text{subject to (1), (4), (5).} \qquad (11)$$

$$\max_{H^C, S^C} U^C = U\left(Y^C, H^C, S^C\right) \quad \text{subject to (2), (6), (8), (9).} \qquad (12)$$

The individually optimal extent of ecosystem service consumption for a given vector $\boldsymbol{R} = \left(R^A, R^B, R^C\right)$ of resource utilization rights is denoted by $H^{i*}(\boldsymbol{R})$ and $S^{i*}(\boldsymbol{R})$. Individual $i = A,B,C$ thus achieves the utility level

$$V^i(\boldsymbol{R}) = U\left(Y^i, H^{i*}(\boldsymbol{R}), S^{i*}(\boldsymbol{R})\right). \qquad (13)$$

2. Model description

Regulating institutions set in t =0 :

A social planner assigns first- and second-generation utilization rights $\boldsymbol{R} = \left(R^A, R^B, R^C\right)$ with the objective of achieving a maximum of intragenerational and intergenerational environmental justice.

In assigning resource utilization rights, the social planner is limited

- by physical feasibility as given by the equations (3), (6) and (7),
- by a political constraint on intragenerational distribution within G_1

$$\underline{\chi} \leq \left(\frac{R^A}{R^B}\right) \leq \overline{\chi}\,, \qquad (18)$$

- by a political constraint on intergenerational distribution

$$\underline{\pi} \leq \left(R^A + R^B\right) \leq \overline{\pi}\,, \qquad (19)$$

- and by a political constraint on access to the remaining resource stock by generation 2

$$\underline{\xi} \leq R^C \leq \overline{\xi}\,. \qquad (20)$$

2. Model description

Indicators of environmental justice:

Ideal of intragenerational and intergenerational environmental justice, derived from the Rawlsian Difference Principle:

$$\max_{R} \; AJ\,(\mathbf{R}) \qquad (14)$$

$$\max_{R} \; EJ\,(\mathbf{R}) \qquad (15)$$

where

$$AJ\,(\boldsymbol{R}) = \min\,[V^{A}(\boldsymbol{R}),\, V^{B}(\boldsymbol{R})] \qquad (16)$$

$$EJ\,(\boldsymbol{R}) = \min\,[V^{A}(\boldsymbol{R}),\, V^{B}(\boldsymbol{R}),\, V^{C}(\boldsymbol{R})]. \qquad (17)$$

2. Model description

Time structure of decision making:

t = 0 : The social planner assigns the resource utilization rights ***R***.

t = 1 : The first-generation individuals *i*=*A*,*B* maximize their utilities:

$$\max_{H^i,\,S^i} U^i = U\left(Y^i, H^i, S^i\right) \quad \text{s.t. } Y^i = \frac{Y_1}{2},$$

$$0 \le H^i \le R^i,$$

$$S^i = R^i - H^i + (1-\nu)\left(R_1 - R^i - H^j\right)$$

t = 2 : The second-generation individuals *i*=*C* maximize their utilities:

$$\max_{H^C,\,S^C} U^C = U\left(Y^C, H^C, S^C\right) \text{ s.t. } Y^C = \frac{\mu Y_1}{2n},$$

$$R^2 = \omega\left(R_1 - H^A - H^B\right), \quad 0 \le H^C \le \gamma R^C,$$

$$S^C = R^C - \frac{H^C}{\gamma} + (1-\nu)\left(R_2 - R^C - (2n-1)\frac{H^C}{\gamma}\right)$$

2. Model description

Depiction of the six determinants of the justice relationship:

Determinant	*Model feature/parameter*
institutions	utilization rights $\boldsymbol{R} = (R^A, R^B, R^C)$
quality of ecosystem service	consumptive and non-consumptive service, H and S, degree ν of rivalry/excludability of non-consumptive service
quantity of ecosystem service	initial endowment R_1 with renewable resource stock, intrinsic resource growth rate ω
population development	population growth rate n
substitutability of ecosystem services	elasticities of substitution σ with manufactured good, θ between ecosystem services
technological development	rates of technical progress μ in manufacturing, γ in harvesting
political restrictions on distribution of utilization rights	constraints $\underline{\chi}$, $\overline{\chi}$ on intragenerational distribution, $\underline{\pi}$, $\overline{\pi}$ on intergenerational distribution, $\underline{\xi}$, $\overline{\xi}$ on access to remaining resource stock

3. Model results

- Analytical model solution for $\nu = 1$ (*S* is private good):

  $for\ i = A, B, C \quad H^{i*} = \ldots \quad S^{i*} = \ldots \quad V^{i*} = \ldots$

- Analytical model solution for $\nu = 0$ (*S* is public good):

  $for\ i = A, B, C \quad H^{i*} = \ldots \quad S^{i*} = \ldots \quad V^{i*} = \ldots$

➢ Numerical simulation of analytical results:

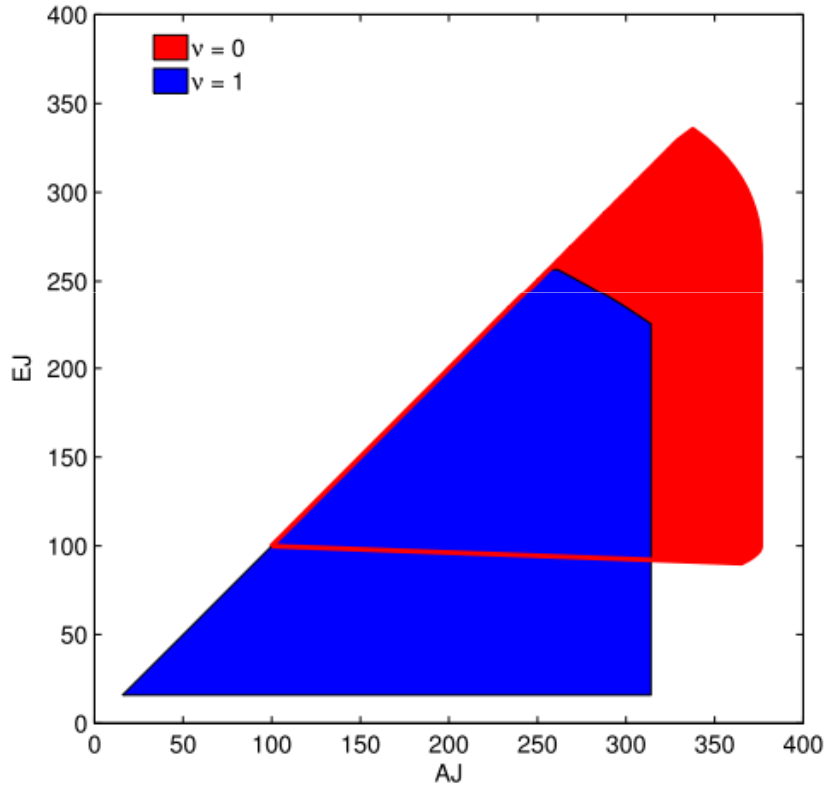
$AJ(\boldsymbol{R}) = \min\left[V^{A}(\boldsymbol{R}), V^{B}(\boldsymbol{R})\right]$

$EJ(\boldsymbol{R}) = \min\left[V^{A}(\boldsymbol{R}), V^{B}(\boldsymbol{R}), V^{C}(\boldsymbol{R})\right]$

for all feasible distributions of resource rights $\boldsymbol{R} = \left(R^{A}, R^{B}, R^{C}\right)$

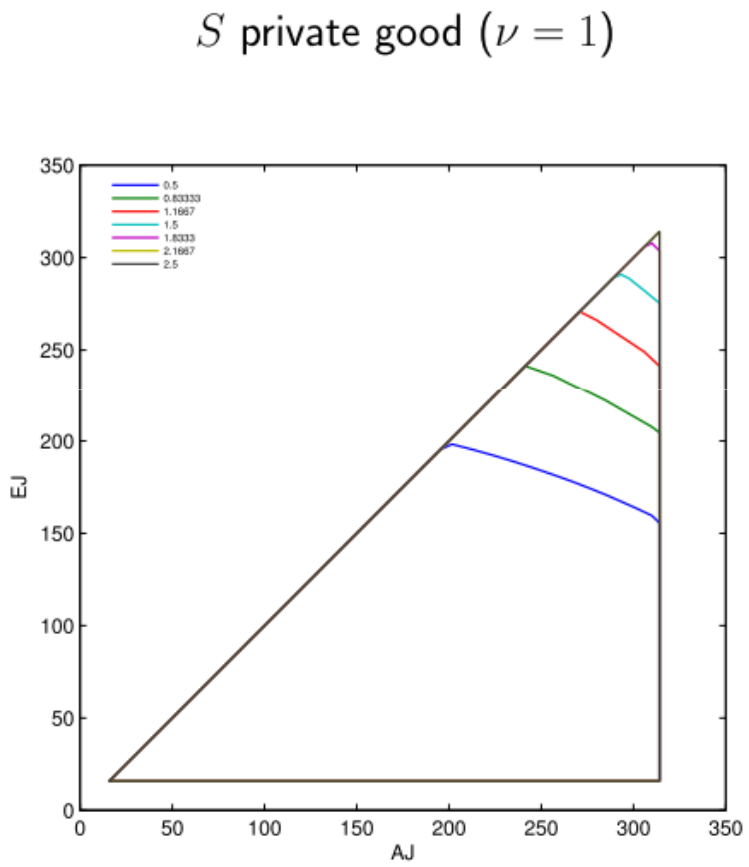
3. Model results: Justice possibility set

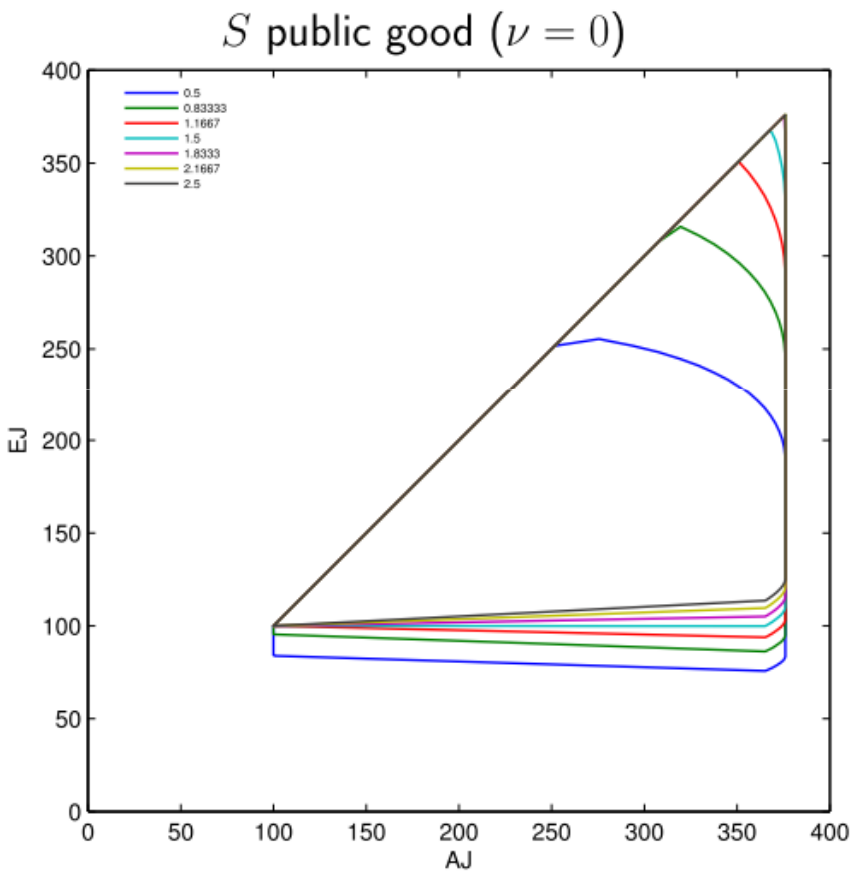
S private good ($\nu = 1$), S public good ($\nu = 0$)



Y_1=1000 R_1=800 n=1 ω=1 μ=1 γ=1 α=0.5 σ=1 β=0.5 θ=1 $\underline{\chi}$=0 $\overline{\chi}$=∞ $\underline{\pi}$=0 $\overline{\pi}$=∞ $\underline{\xi}$=0 $\overline{\xi}$=∞

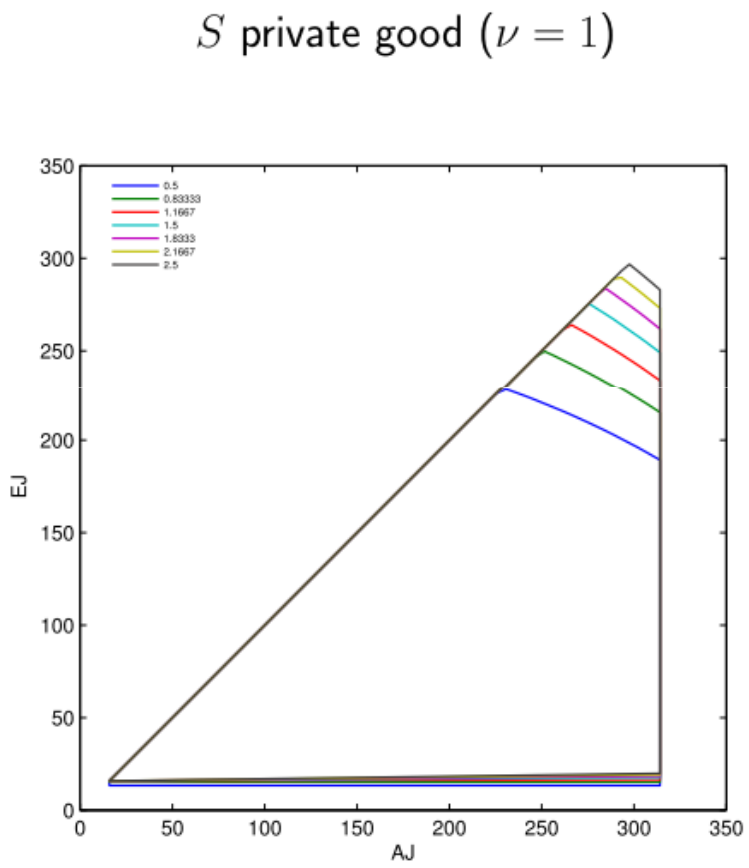
3. Model results:
Justice possibility set (intrinsic resource growth ω)

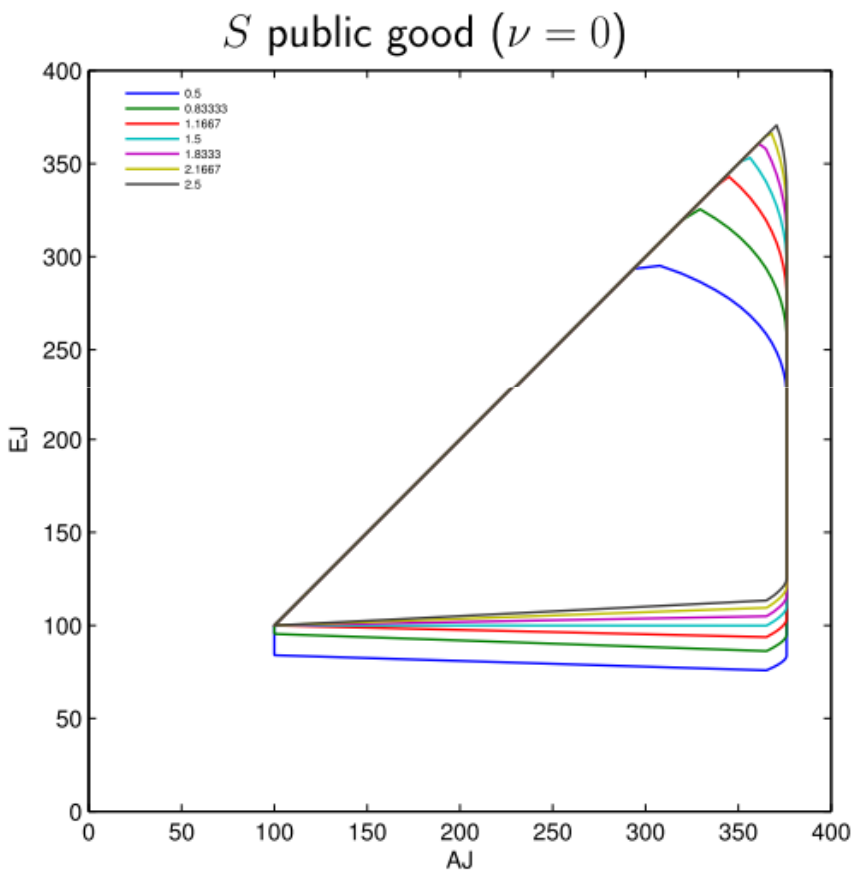




Y_1=1000 R_1=800 n=1 $\omega \in \{0.5, 2.5\}$ μ=1 γ=1 α=0.5 σ=1 β=0.5 θ=1 $\underline{\chi}$=0 $\overline{\chi}$=∞ $\underline{\pi}$=0 $\overline{\pi}$=∞ $\underline{\xi}$=0 $\overline{\xi}$=∞

3. Model results:
Justice possibility set (tech. progress in harvesting γ)

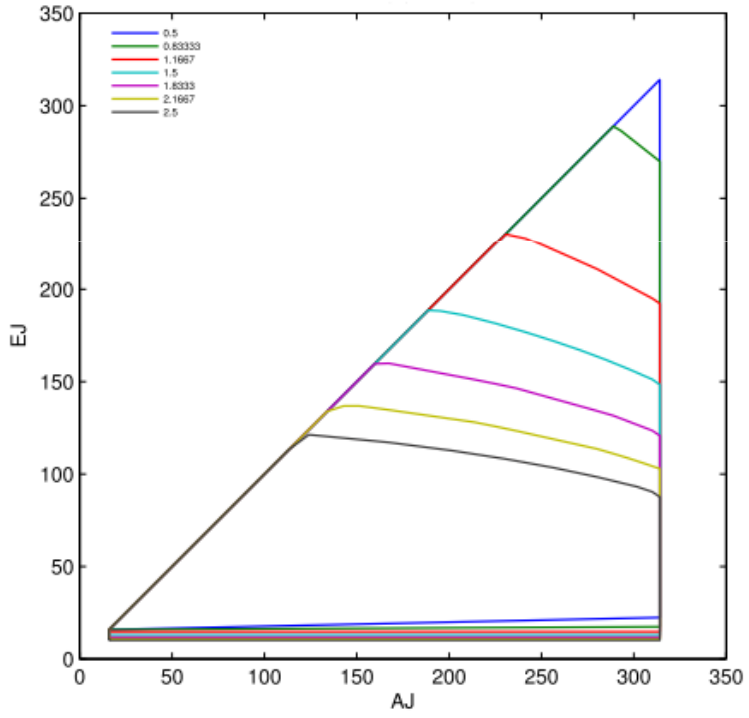




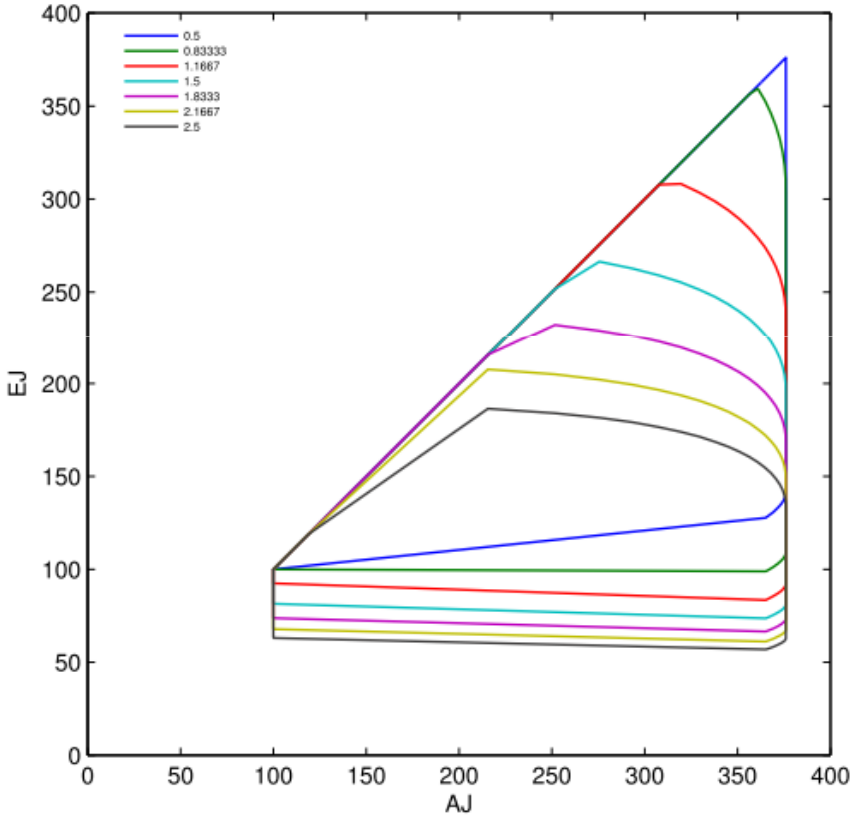
Y_1=1000 R_1=800 n=1 ω=1 μ=1 $\gamma \in \{0.5, 2.5\}$ α=0.5 σ=1 β=0.5 θ=1 $\underline{\chi}$=0 $\overline{\chi}$=∞ $\underline{\pi}$=0 $\overline{\pi}$=∞ $\underline{\xi}$=0 $\overline{\xi}$=∞

3. Model results:
Justice possibility set (population growth *n*)

S private good ($\nu = 1$)

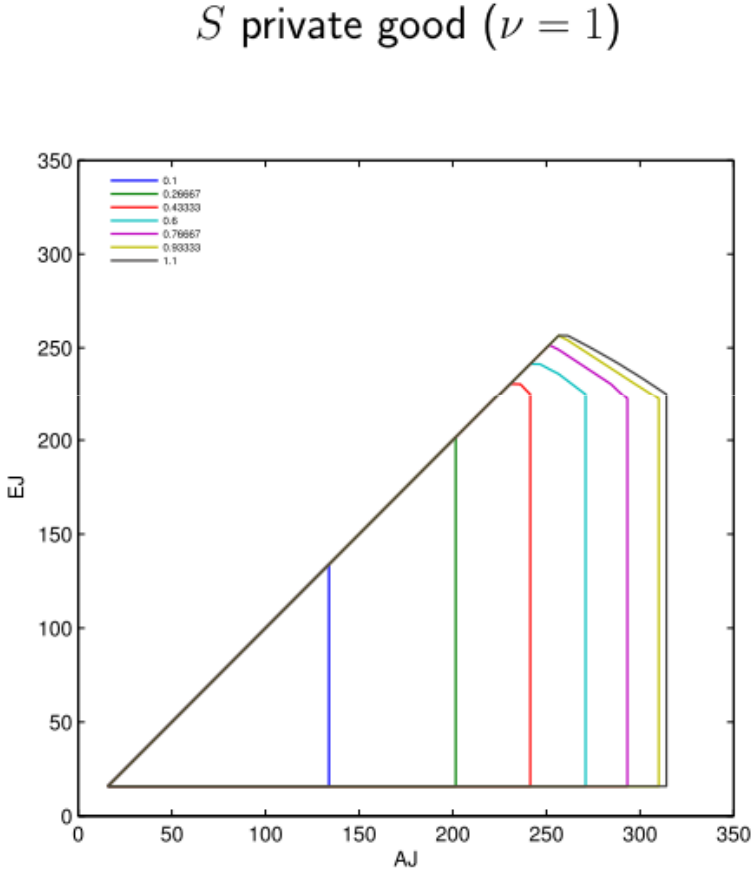


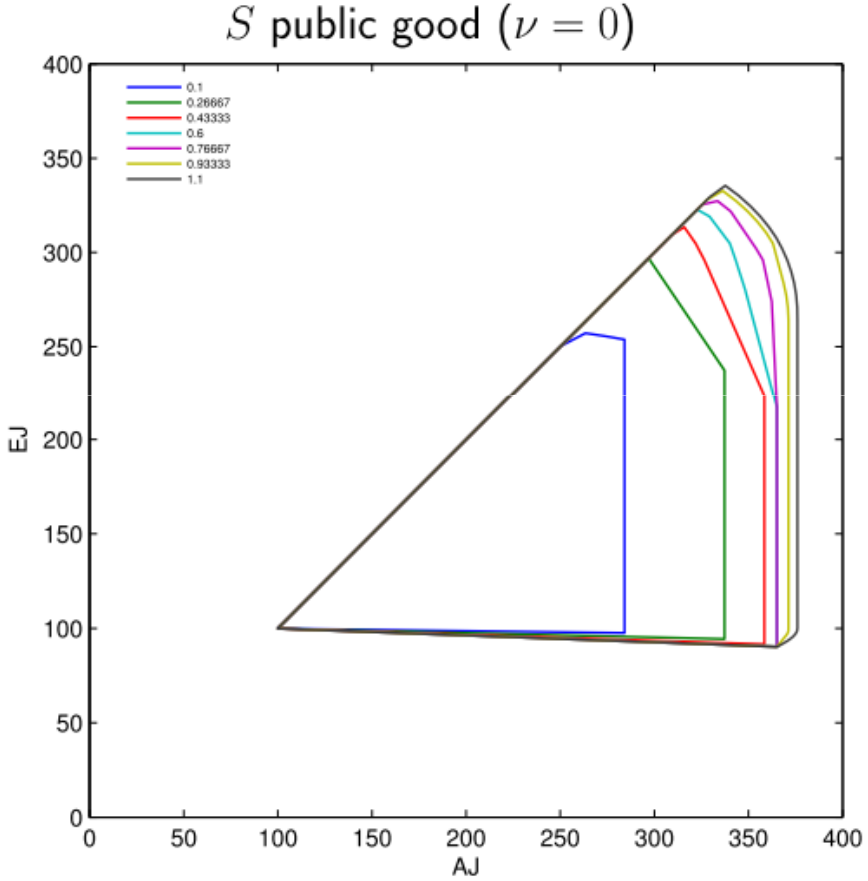
S public good ($\nu = 0$)



Y_1=1000 R_1=800 $n \in \{0.5, 2.5\}$ ω=1 μ=1 γ=1 α=0.5 σ=1 β=0.5 θ=1 $\underline{\chi}$=0 $\overline{\chi}$=∞ $\underline{\pi}$=0 $\overline{\pi}$=∞ $\underline{\xi}$=0 $\overline{\xi}$=∞

3. Model results:
Justice possibility set (intra. distribution constraint χ)

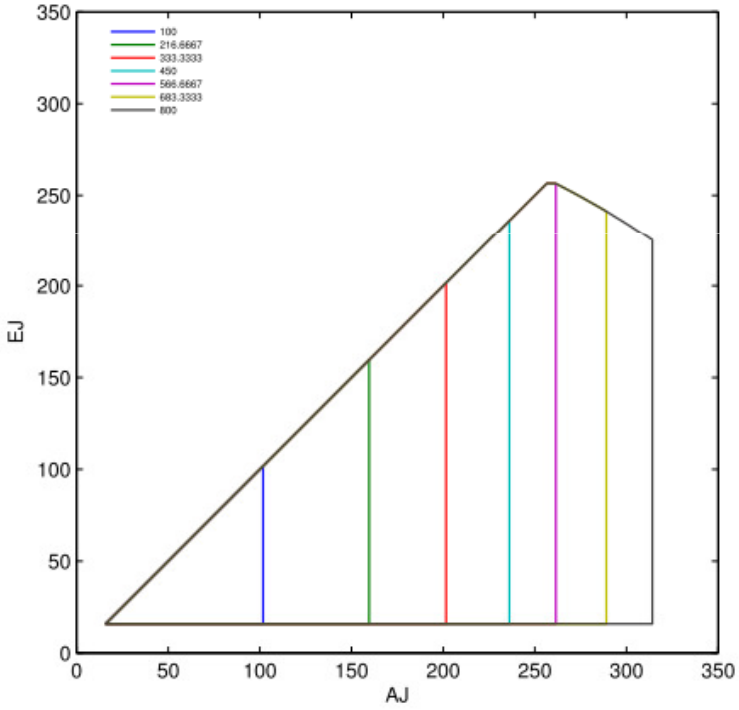




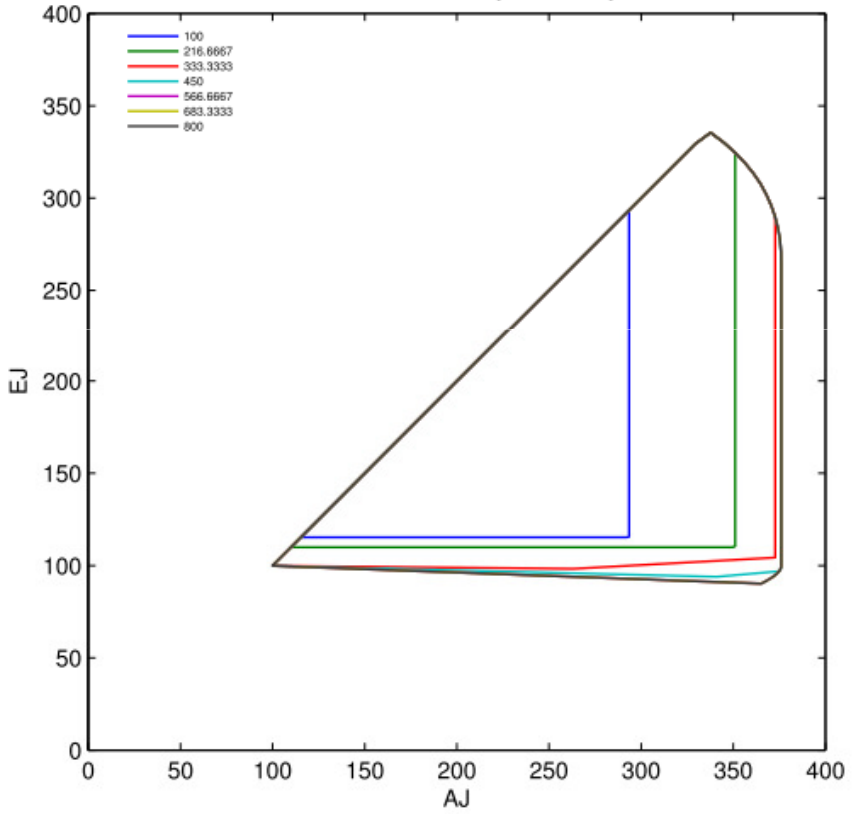
Y_1=1000 R_1=800 n=1 ω=1 μ=1 γ=1 α=0.5 σ=1 β=0.5 θ=1 $\underline{\chi}$=0 $\overline{\chi} \in \{0.1, 1.1\}$ $\underline{\pi}$=0 $\overline{\pi}$=∞ $\underline{\xi}$=0 $\overline{\xi}$=∞

3. Model results:
Justice possibility set (inter. distribution constraint π)

S private good ($\nu = 1$)



S public good ($\nu = 0$)



Y_1=1000 R_1=800 n=1 ω=1 μ=1 γ=1 α=0.5 σ=1 β=0.5 θ=1 χ=0 $\overline{\chi}$=∞ $\underline{\pi}$=0 $\overline{\pi} \in \{100, 800\}$ ξ=0 $\overline{\xi}$=∞

4. Summary & discussion

- Normative orientation towards justice (desirability of degrowth):
  - intragenerational
  - intergenerational
- Model depicts all important characteristics of ecosystem services (consumptivity, rivalry, excludability, substitutability)
- Instrument of justice: assignment of resource utilization rights
- Analysis of justice relationships based on justice possibility set:
  - independency
  - facilitation („win-win“)
  - rivalry („trade-off“)

  depending on certain (de)growth determinants