**Overview, design concepts, and details (ODD) for the stylized resource-capability system model**

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| **Overview** | |
| Purpose | To perform a comparative evaluation of the effects of different principles of distribution on welfare attainment in a stylized finite-resource social-environmental system. |
| State variables and scales | There are two agent (turtle) types: individuals and (social-environmental) resource systems. Individuals possess an attribute called ‘access potential’ which differentiates them from one another. In the language of the capability approach, the access potential may be thought of as a personal conversion factor that determines one’s ability to attain an essential need. In the model we also consider another attribute called ‘social capital’ as being completely correlated with an individual’s access potential attribute. An individual’s social capital determines the number of resource systems and other individuals that they may interact with.  Resource systems are characterized by their ‘system state’, an indicator of their health and capacity to provide the essential need. This attribute variable may be thought of as a socio-environmental conversion factor. The values of the access potential of individuals and the system state of resource systems both range from 0 to 1.  Access potential values do not change over time except when a distributive principle is implemented. The system state attribute of resource systems evolves as they provide the essential need to people and in the process accrue damages that need maintenance and repair. |
| Process overview and scheduling | Setup:   * Individuals and resource systems are initialized with random access potential and system state values. * Individuals are linked with resource systems and other individuals; the size of each one’s network depends on their social capital attribute.   Go:   * Individuals assess (or sense) their well-being in terms of their capability attainment running average. * If this is below a certain threshold, the individual will call on the resource system unit in their network that is in the best state and seek to obtain the capability (essential need). * The resource system unit suffers some damage as it provides the capability, which degrades its system state and potential to provide the capability. The system state is evaluated each tick. * When their capability attainment running average is above a satisfactory threshold, an individual will contribute to maintaining resource systems by spending effort to repair the damages these systems have accrued. * Under certain distributive justice principles, individuals with satisfactory levels of capability attainment will help individuals in their network with inadequate access potential to obtain the capability or essential need from a resource system unit before contributing to maintenance and repair of resource systems. |
| **Design concepts** | |
| Theoretical and empirical background | Actor heterogeneity in society entails unequal vulnerability to climate change impacts, and means that some people and groups will be better able to adapt than others. Justice requires a fair and equitable distribution of risks and benefits of adaptation actions across society (including as a means to foster resilience). Different principles of distribution are operationalized and evaluated against one another in terms of their effect on peoples’ ability to fulfil their essential needs, or capabilities in the language of the capability approach. |
| Individual decision making | Each tick, individuals evaluate their state of well-being. If their capability attainment running average is below a certain threshold, they will call on a resource system unit in their network to try to obtain the capability (or essential need). If it is above the threshold, the person will contribute to repairing damages incurred by resource systems, or to help ensure that people with inadequate access potential are also able to attain the capability (essential need), depending on the principle of distribution followed. |
| Learning | None. |
| Individual sensing | Individual agents are aware of the states of other individuals as well as resource systems in their network. This allows them, for example, to select the most needy individuals in their network to help, or to perform repairs on the most damaged resource system unit(s). |
| Individual prediction | None. |
| Interaction | Individuals interact with the resource system units and other individuals in their own network. They call on resource systems to obtain the essential need (capability) and to repair the damages they have accumulated. Under certain principles of distribution, they seek out individuals to help and do so by sharing some of their access potential or by obtaining the capability on their behalf. |
| Collectives | Individuals and resource systems are linked in networks. However, each individual has their own network, and a person in that network is unlikely to have the same network for themselves as well. |
| Heterogeneity | Individuals possess different amounts of the access potential attribute, which sets up unequal capacities to obtain the essential need from resource systems. |
| Stochasticity | The following elements are stochastic in the model:   * The individuals and resource system units to which an individual is connected or linked. * The value of the access potential attribute for each person. * The initial system state value for each resource system unit. * The process of calling on resource system units and obtaining the capability or essential need is probabilistic. |
| Observation | The model provides the following output:   * The capability attainment of individuals, which indicates their state of well-being. * The system state of resource systems, also an indicator of their well-being and capacity to provide the essential need. |
| **Details** | |
| Implementation details | The model is implemented in NetLogo 6.2.0. It is available at <https://github.com/aashisjoshi/resource-capability-ABM>  The following functions are used:   * Likelihood of an individual attaining the essential need (capability) from a resource system unit  P (capability attainment) = access-potential \* (system-state) ^ (1/2) * Capability attainment running average of individuals  capability-attainment-running-average = Mean (capability-attainment, 5 most recent ticks) * Damage incurred by a resource system unit when providing the capability  system damage with capability output = capability-output \* ( 1 – (system-state) ^ (1/2) ) * Recovery of a resource system unit with maintenance and repair effort from individuals  max. maintenance effort by individual = capability-attainment-running-average  system recovery with maintenance effort = maintenance-effort \* (system-state) ^ (1/2) * Random damage to resource system units  random damage = [ 0, random-damage-limit ] * System state of resource system units  damage-impact = 1 / ( 1 + exp ( - ( total-system-damages – ( minimum-system-damage-this-run + system-damage-range-this-run / 2 ) ) ) )  repair-impact = 1 / ( 1 + exp ( - ( total-system-repairs – ( minimum-system-damage-this-run + system-damage-range-this-run / 2 ) ) ) )  net-system-state-change = ( - damage-impact + repair-impact – random-damage )  If net-system-state-change >= 0: system-state = system-state-old + ( 1 – system-state-old ) \* net-system-state-change If net-system-state-change < 0: system-state = system-state-old \* ( 1 – ( - net-system-state-change / 100 ) )   There are three different rules according to which the access potential may be redistributed in the model, besides the ‘baseline’ scenario in which there is no redistribution of access potential among individuals.   * Egalitarian principle   Each individual contributes their entire access potential into a communal fund from which each then withdraws an equal amount of access potential with which to try to attain the essential need (capability). * Difference-proportionate sharing   An individual with a satisfactory level of capability attainment will share with the individual in their network who has the lowest capability attainment running average an amount of their access potential in proportion to the difference between the access potentials of the two individuals. * Sufficientarian principle  An individual with a satisfactory level of capability attainment will, before repairing damages on resource systems, contribute their effort to helping individuals in their network having unacceptable capability attainments obtain the essential need from a resource system unit (in order to try to ensure that all individuals reach a certain minimum threshold of well-being). |
| Initialization | Individuals and resource systems are set up and linked; the number each individual is linked with is based on their social capital attribute value. Each individuals is assigned an access potential value from 0 to 1. |
| Input | Number of individuals and resource system units; desirable, acceptable, and unacceptable capability attainment thresholds; distribution principles for the access potential attribute; extent of random damage (as a representation of external stresses such as a climate change impact) suffered by resource systems. |
| Submodels | None. |

Authors: Aashis Joshi ([a.r.joshi@tudelft.nl](mailto:a.r.joshi@tudelft.nl))   
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