Assessment of location and service level assignment of HC facilities taking into account organizational dynamics

The problem

- Location of HC has attracted much interest
- Most published work concerns location in a static environment as far as organizational dynamics and policy making incentives are concerned
- Only modification of service level as exogenous variable has been taken into account

The problem

- **In reality**:
- Service level (range of specializations, physicians' skills, internal organization, etc) depends on the resource endowment of a HC
- But, service level also depends on the utilization of HC – the more patients visit the HC, the more the centre attracts good personnel, personnel gains more experience, services are better organized, etc.

The problem

- Service also depends on the incentives provided by government or other stakeholders to the physicians and paramedical personnel
- Finally, service depends on the physical capacity of the HC in terms of facilities, equipment and human resources

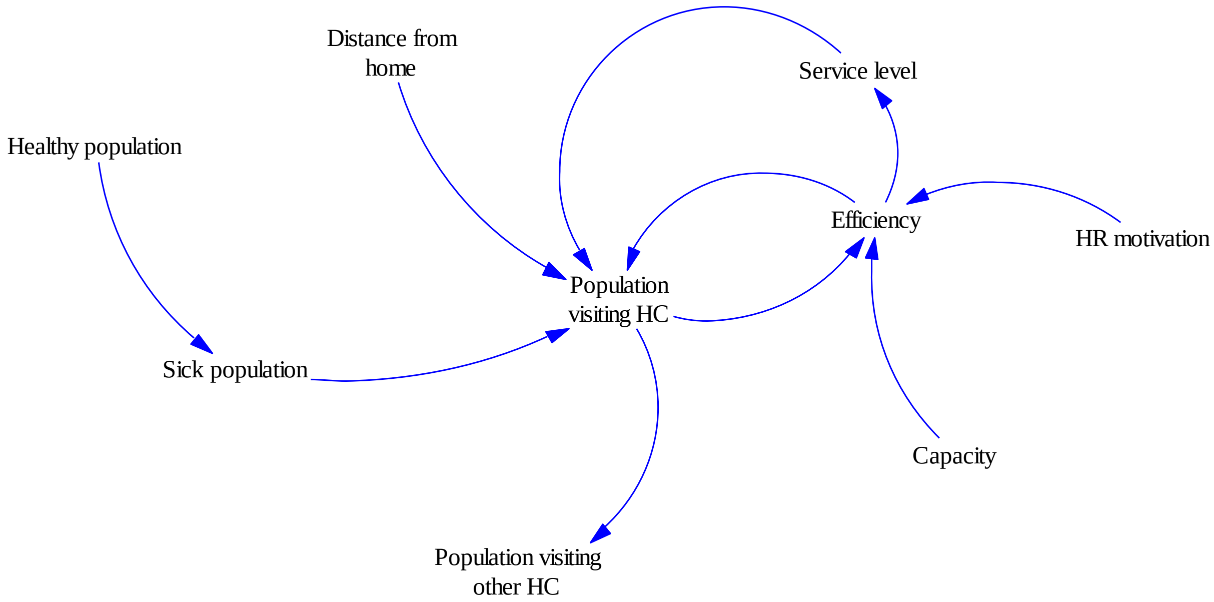
The problem

- Customers/patients base their decision to whether they will visit a specific HC on two measures: ***distance*** from their home and level of ***service*** (as the reputation is spread by word-of-mouth)
- When designing a network of HC (health facilities, in general) using quantitative models, distance is an exogenous independent decision variable, but service is not (it is only its initial value)

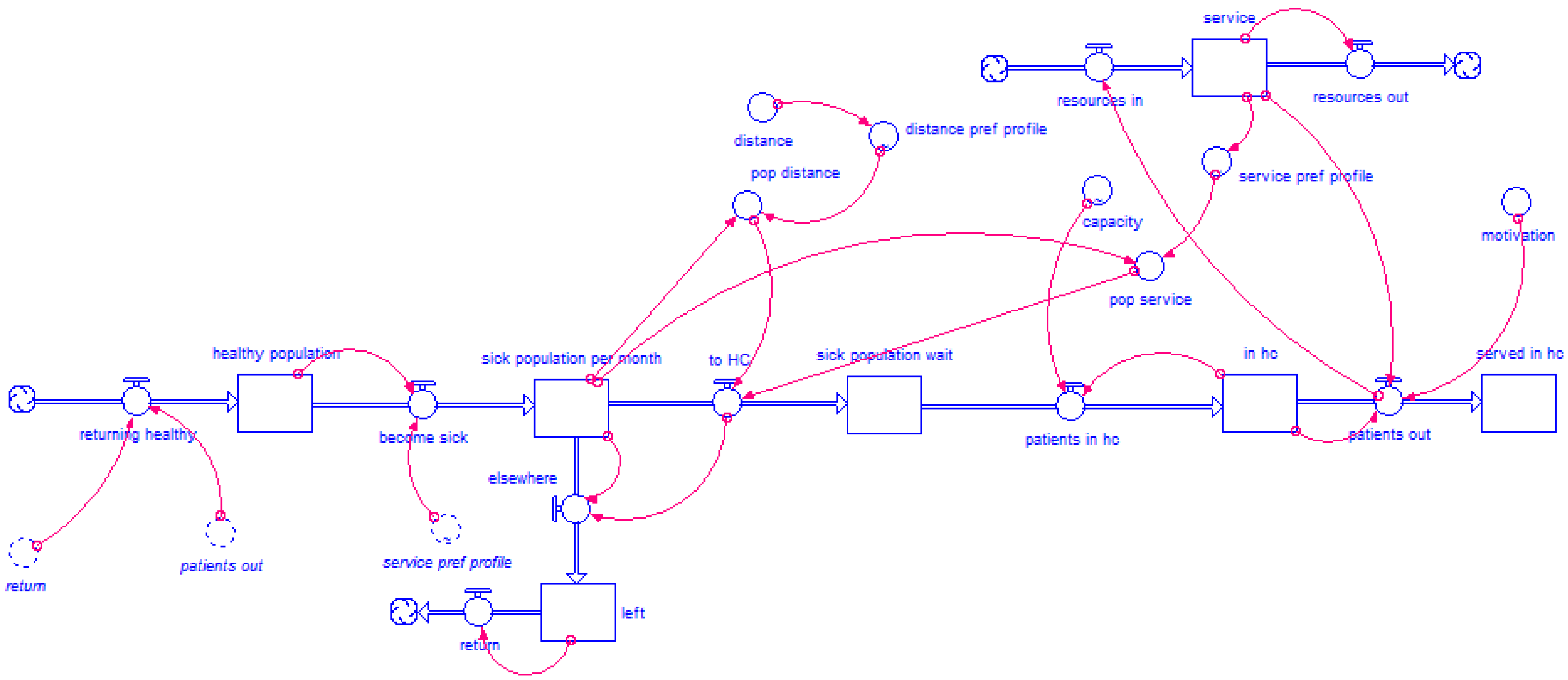
The problem – The model

- The level of service depends on the level of the utilization of the HC, and its efficiency (throughput time) which is a function of the ***designed capacity*** and the **incentive/ motivation scheme(s)** provided.
- We develop a system dynamics model and use different customer/patient and physicians *behavioural profiles* to explore this situation and provide insights for the design of health provision systems at the regional level

The model of the situation – Causal Loop Diagram

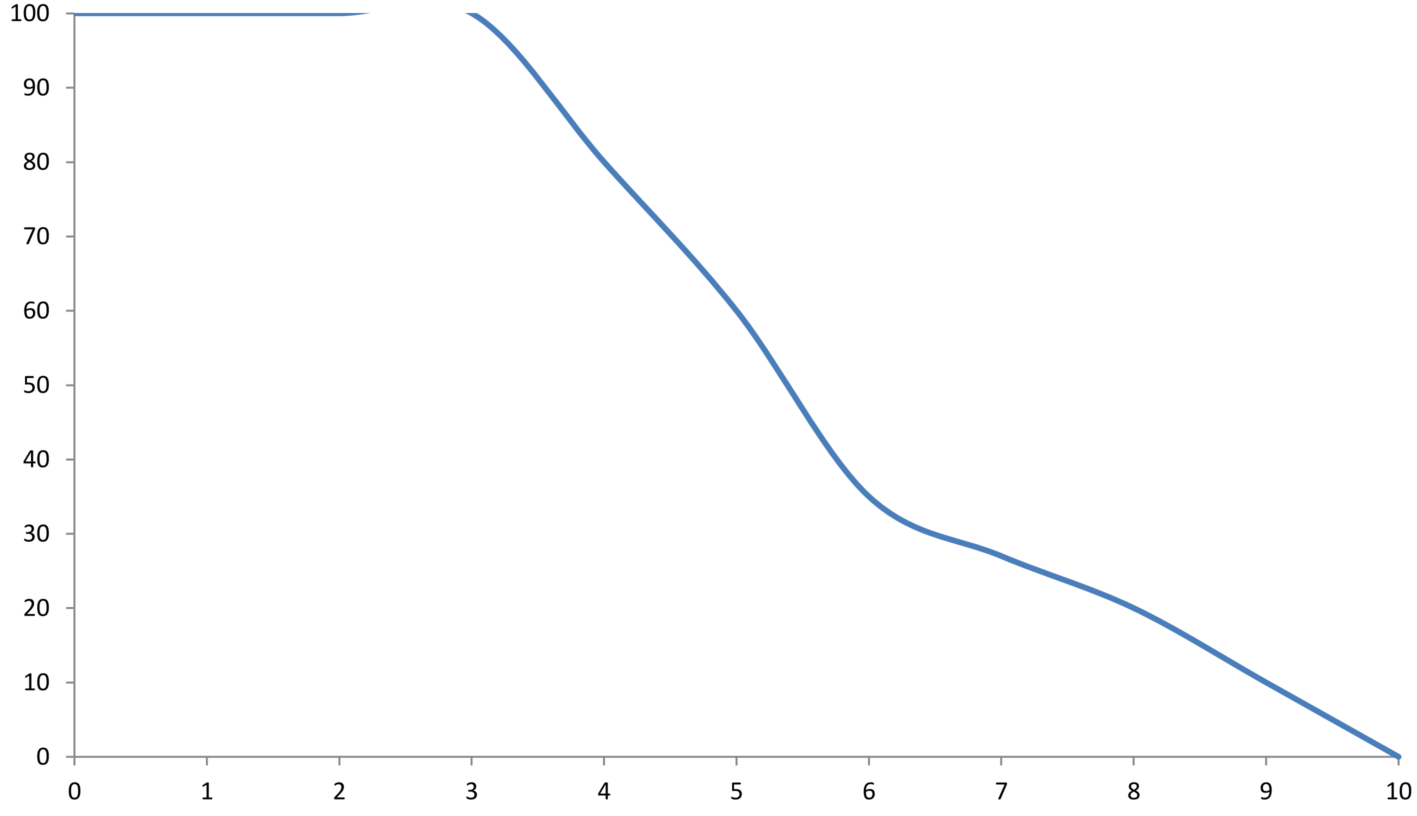


The system dynamics model (structure)



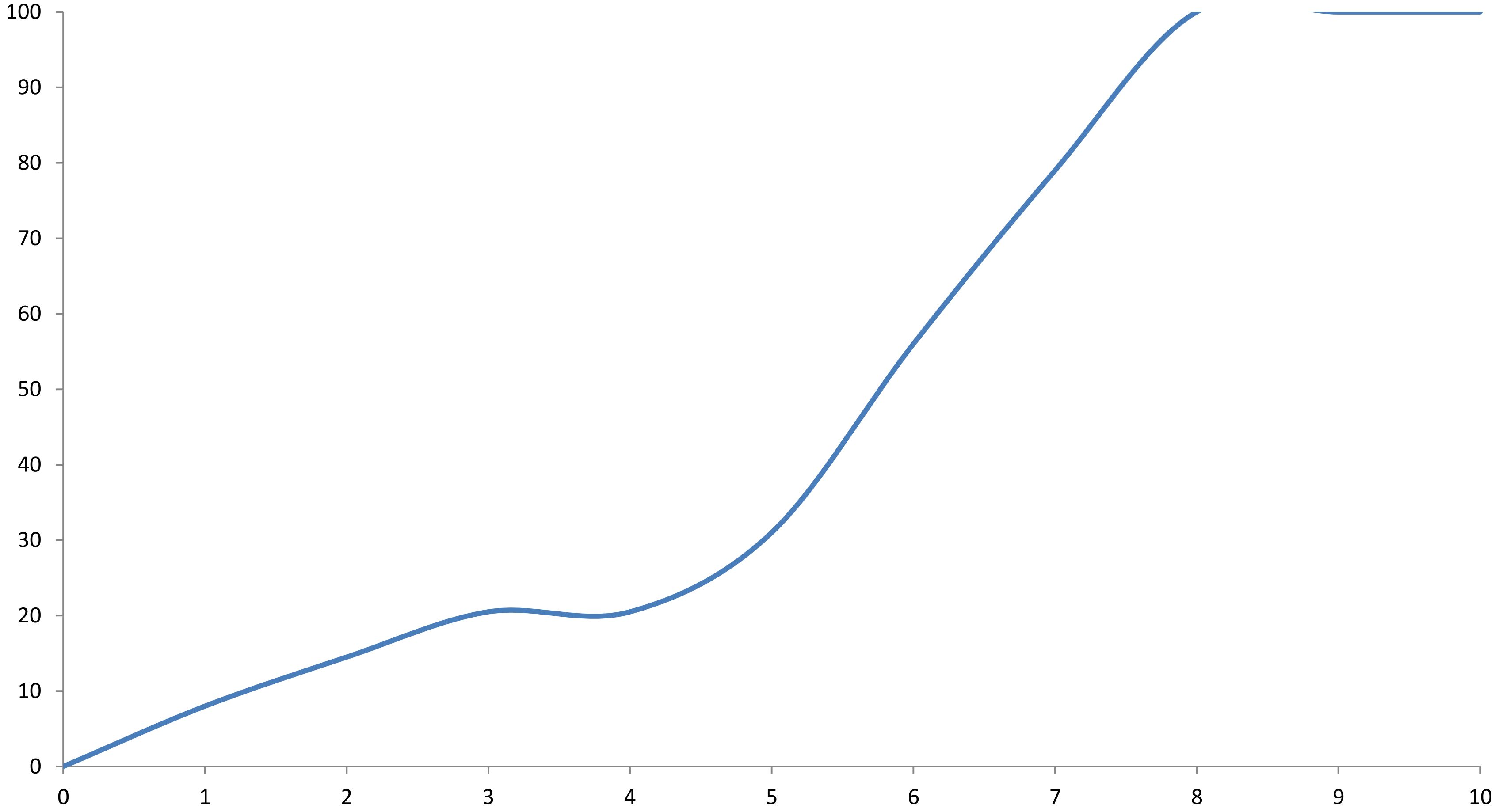
The system dynamics model

(distance preference profile - % of sick people (y) that tolerate distance (x))



The system dynamics model

(service preference profile - % of sick people (y) that tolerate service level (x = 0 to 50))



The model (initial values of state (dependent) variables)

- healthy_population = 1000
- sick_population_per_month = 0
- sick_population_wait = 0
- left = 0
- in_hc = 5
- served_in_hc = 0
- service = 10

State equations

- **service(t) = service(t - dt) + (resources_in - resources_out) * dt** - *level of service at time t*

where

resources_in = patients_out – *resources are supplied and developed on the basis of the patients that served*

resources_out = service*0.5 – *natural depletion of resources*

State equations

- **in_hc(t) = in_hc(t - dt) + (patients_in_hc - patients_out) * dt** – *patients in HC at time t*

where

patients_in_hc = capacity-in_hc – *input of patients = available capacity*

patients_out = (in_hc*service/100)*(1+motivation)

- output is a function of service and motivation

State equations

- **served_in_hc(t) = served_in_hc(t - dt) + (patients_out) * dt** – *number of patients served up to time t*

where

patients_out = (in_hc*service/100)*(1+motivation)

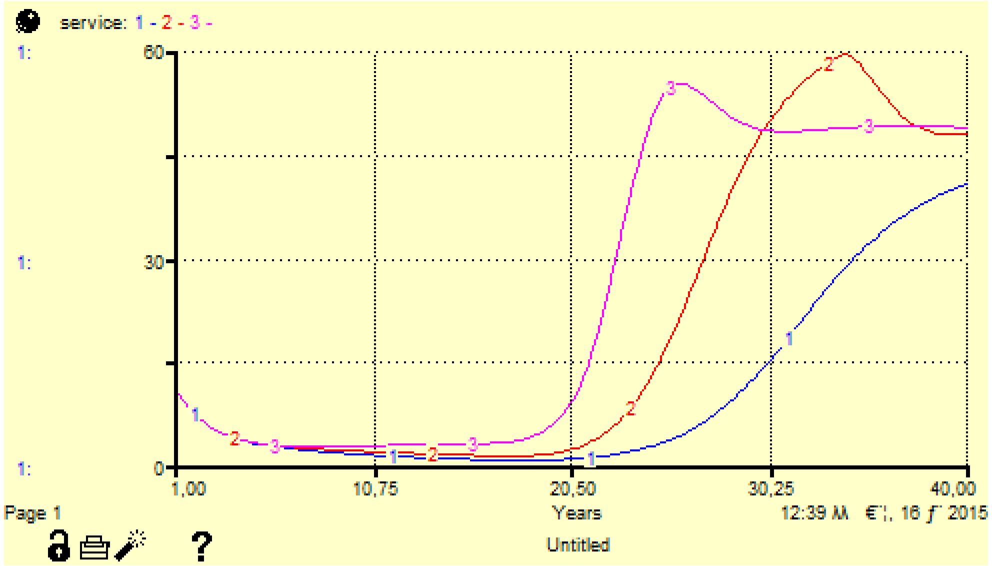
- rate of output of patients is a function of service and motivation

Simulations

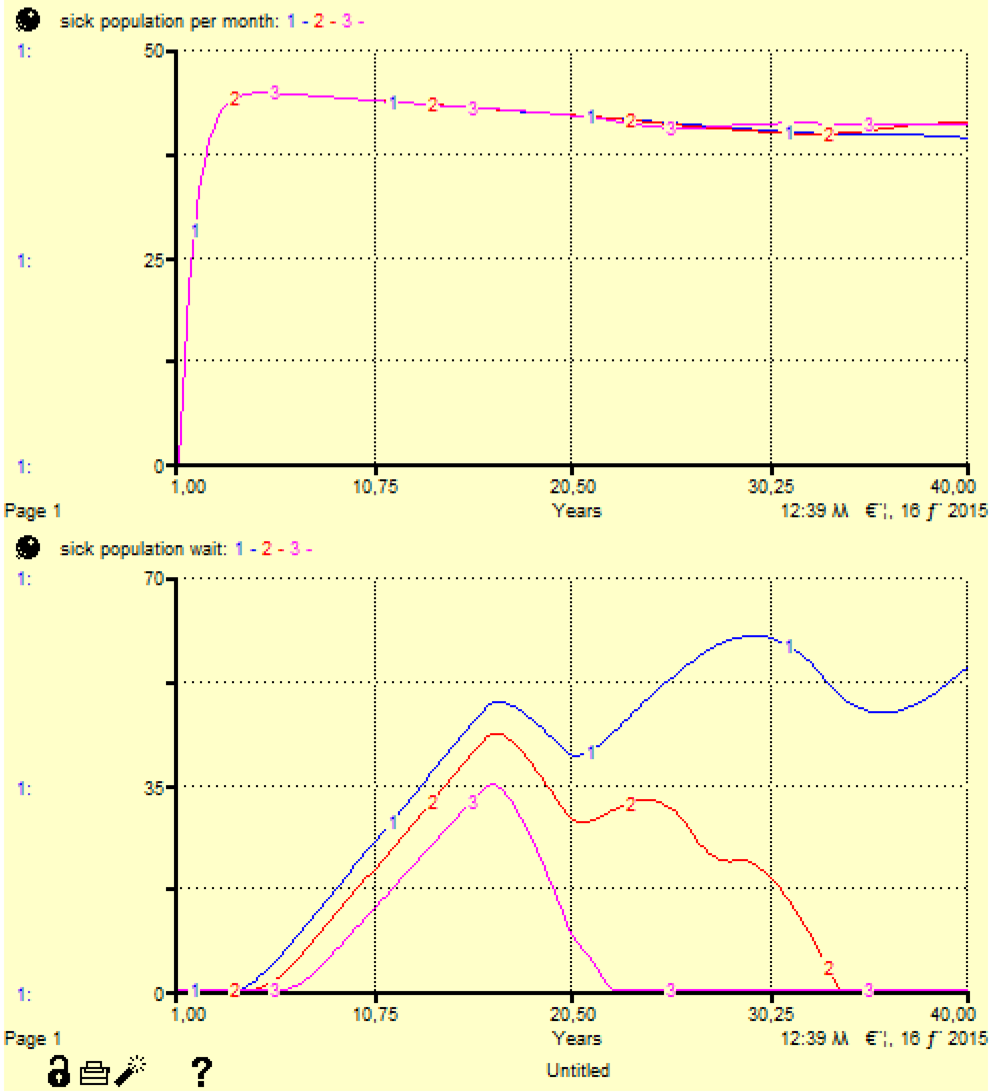
- Simulation time = 40 months
- Capacity profile:
    - 0 – 16 mo -> 20 cases/mo
    - 16 – 20 mo -> transient to 50 cases/mo
    - 20 – 40 mo -> 50 cases/mo
- patient behavioural profiles as above

Simulations – effect of capacity (capacity multiplier values: 1, 1.2, 1.5)

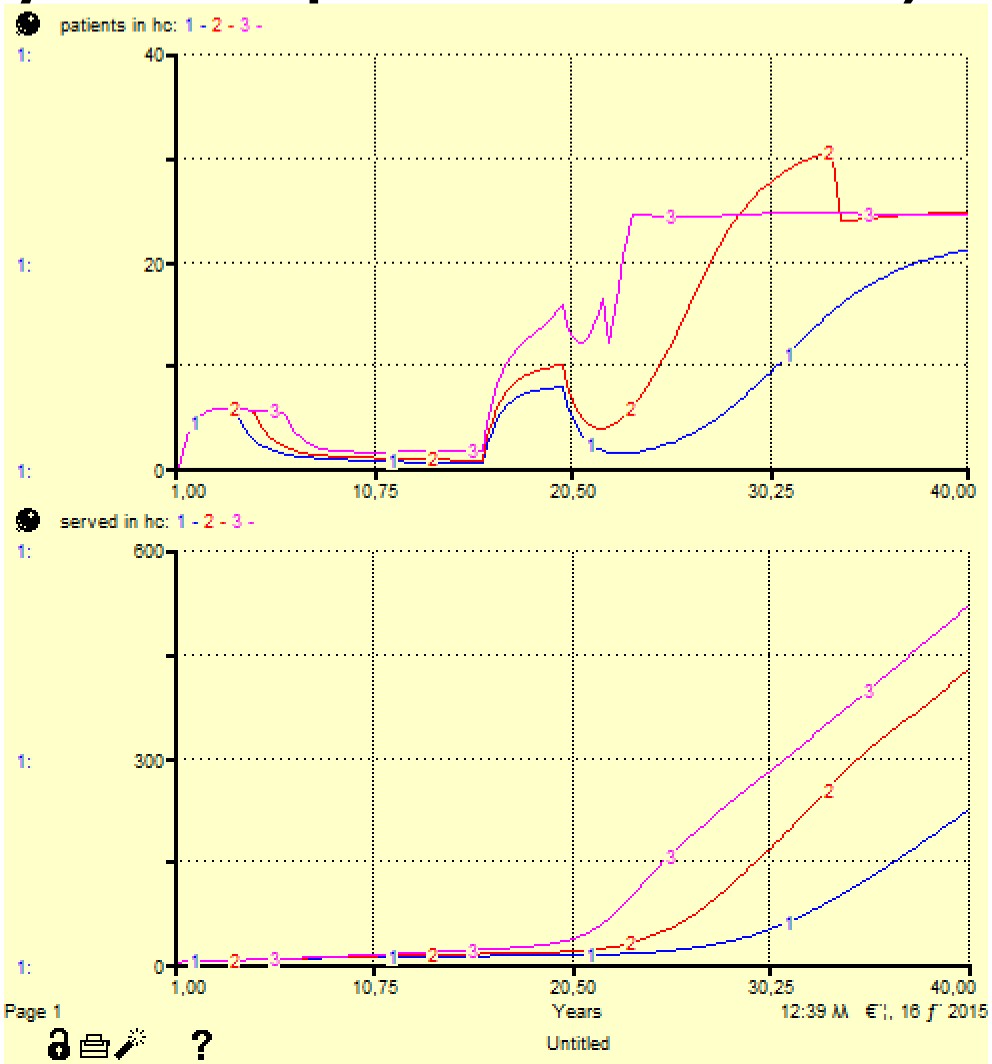
- distance = 8 Km, motivation = 0,8



Simulations – effect of capacity (capacity multiplier values: 1, 1.2, 1.5)

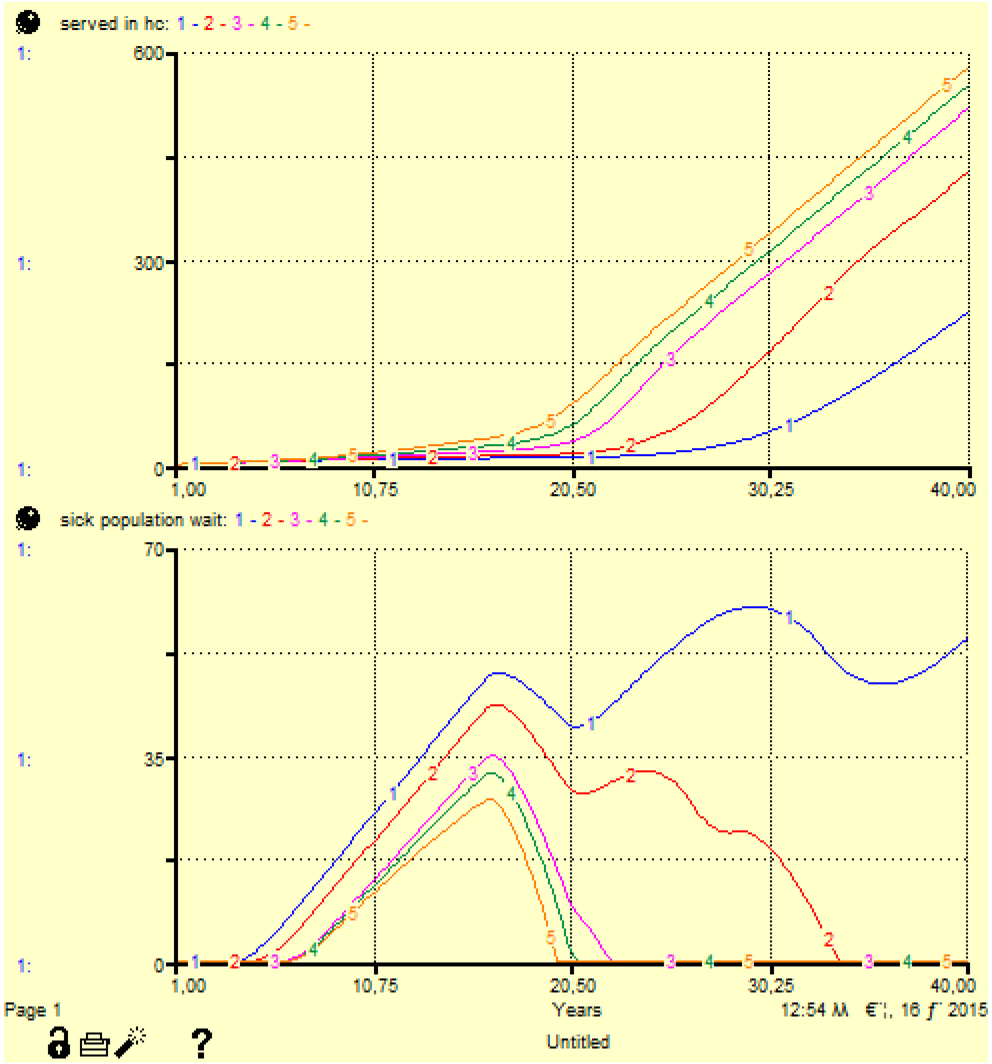


Simulations – effect of capacity (capacity multiplier values: 1, 1.2, 1.5)

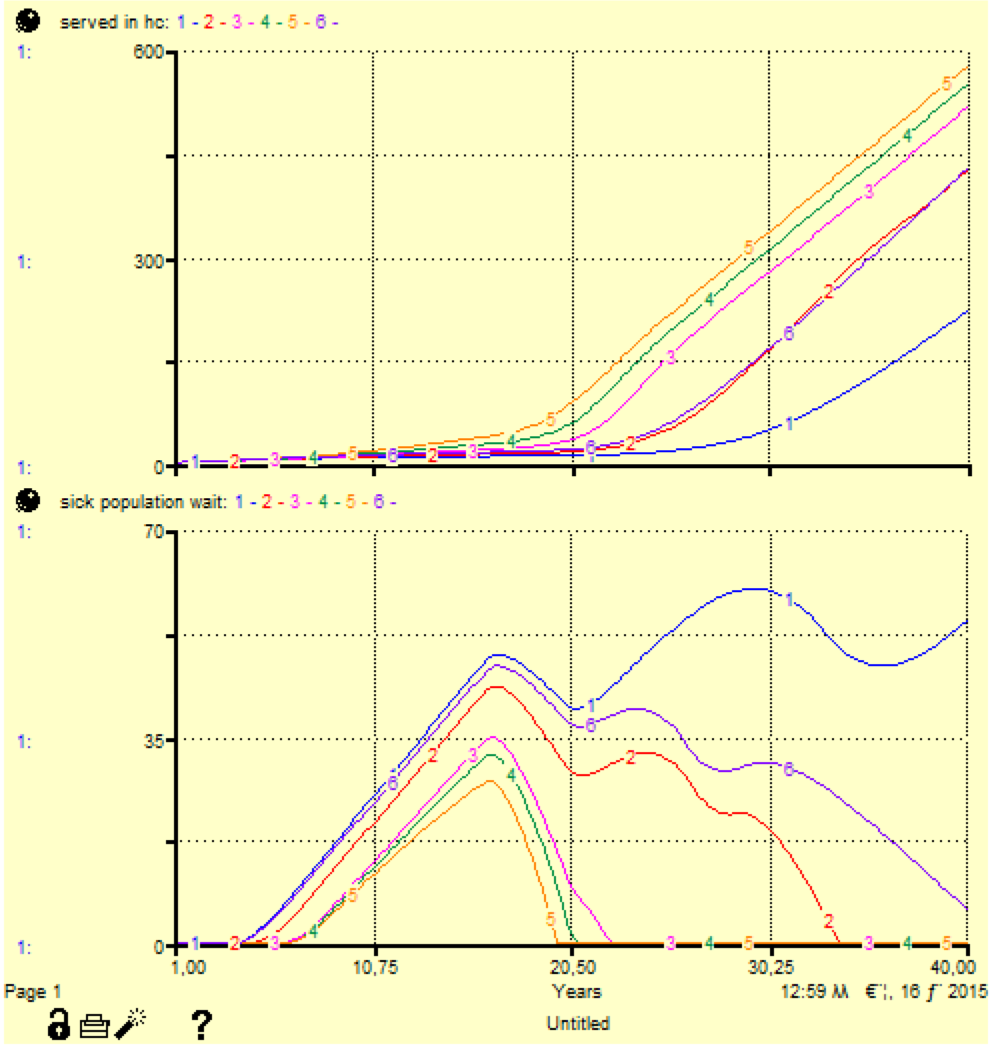


Simulations – effect of motivation

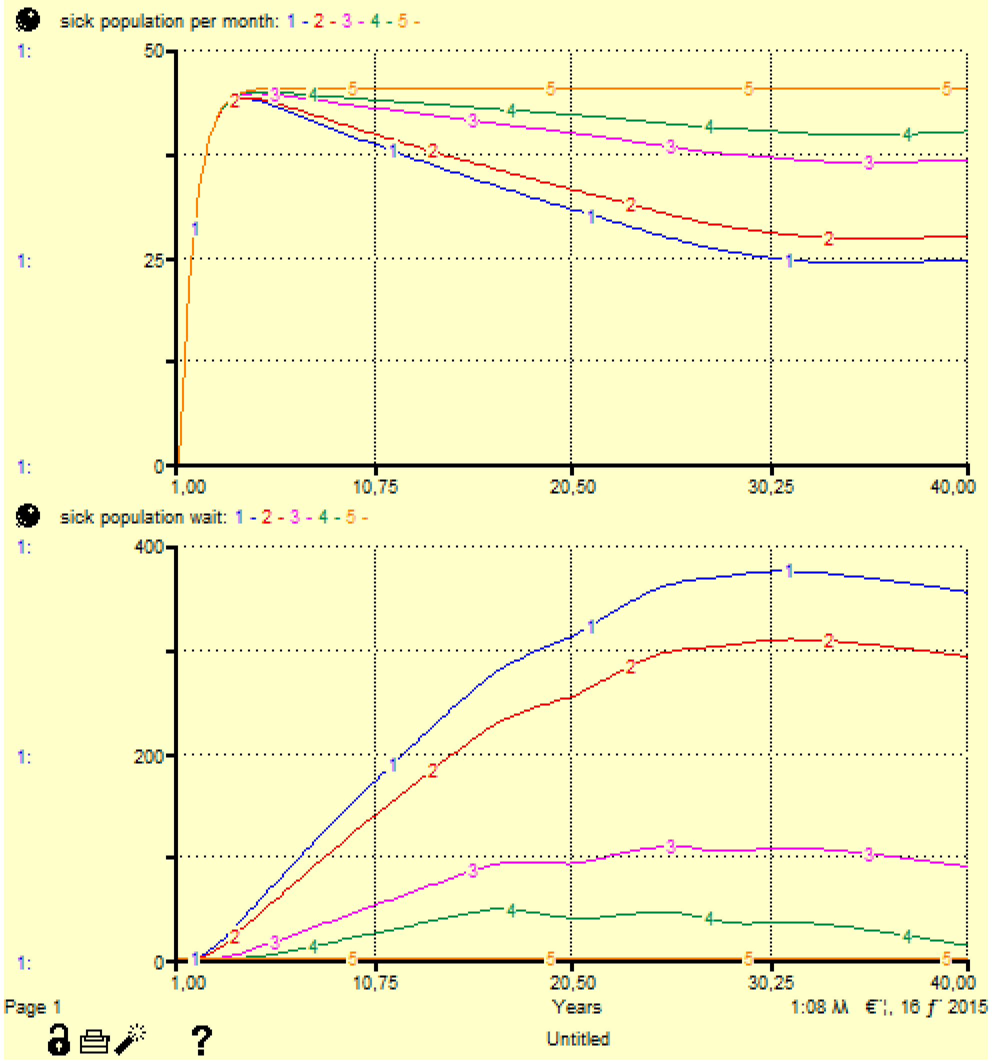
(capacity mult value: 1.5; motivation: 1, 1.2) –no effect in other variables



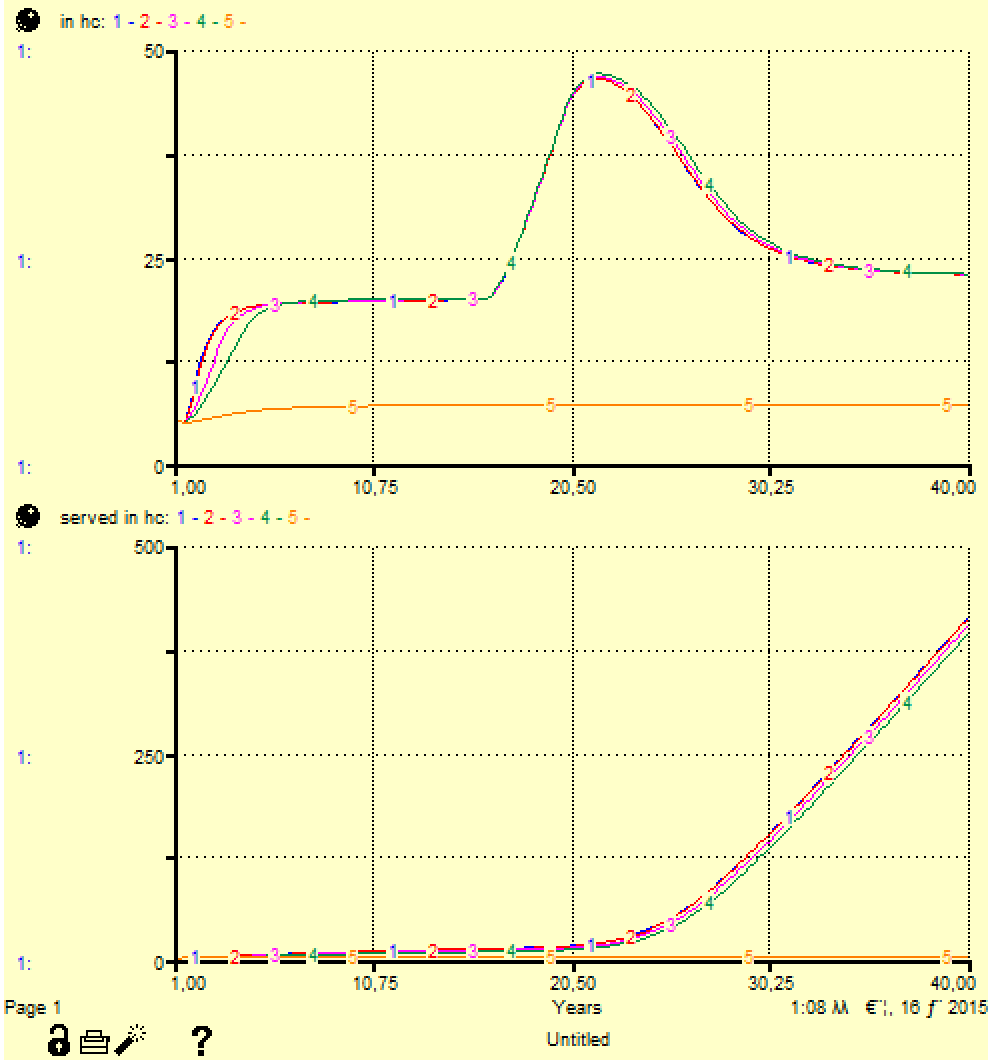
Simulations – effect of motivation (capacity mult value: 1; motivation: 1)



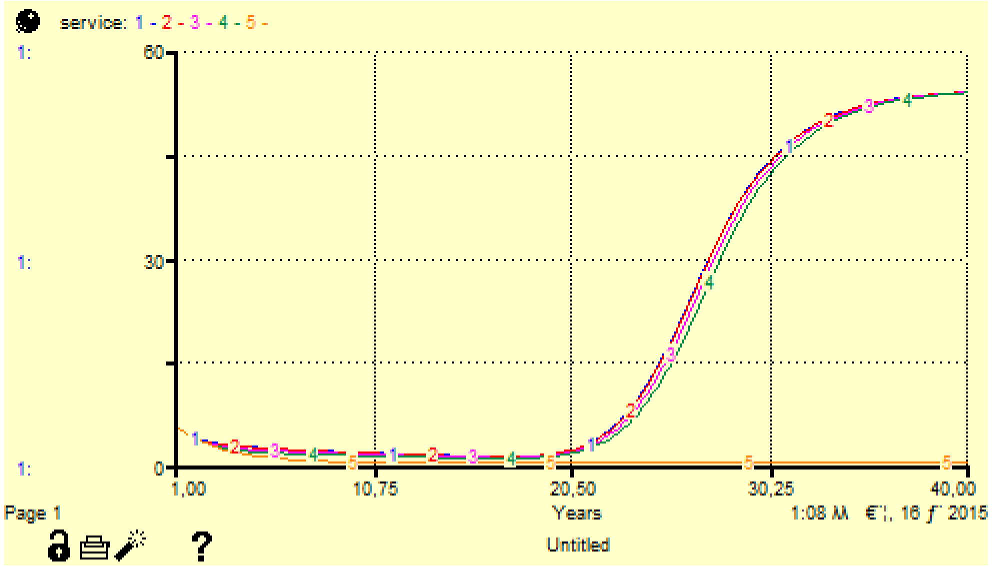
Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1; motivation: 1)



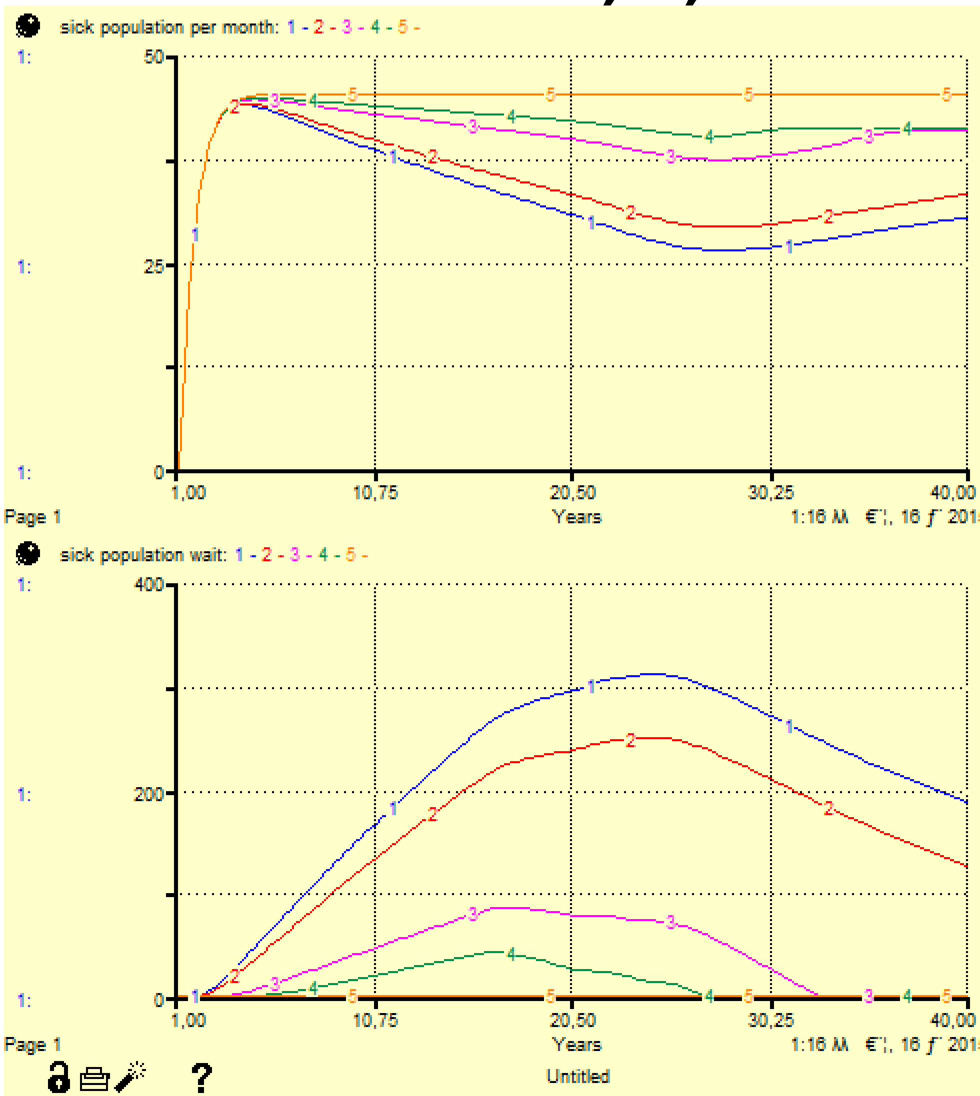
Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1; motivation: 1)



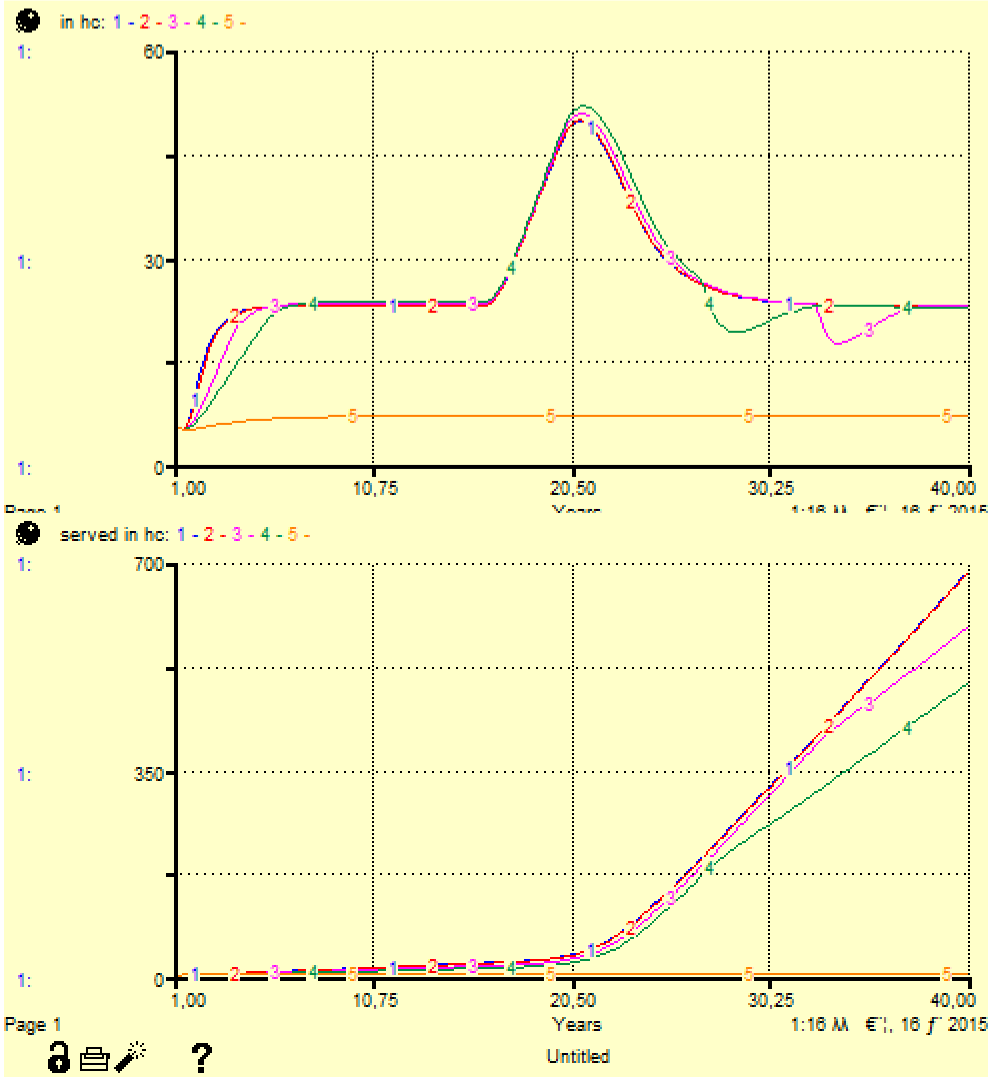
Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1; motivation: 1)



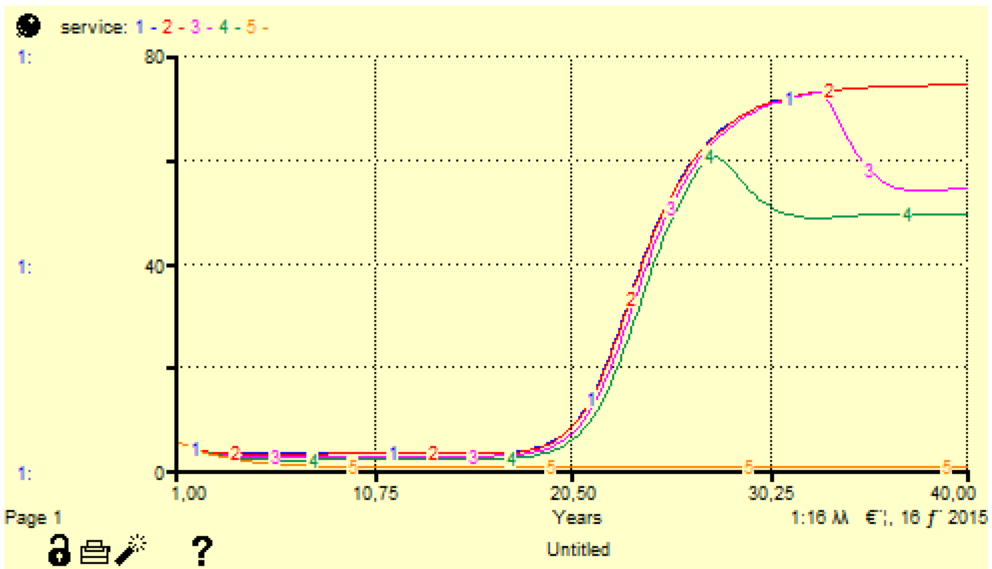
Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1,2; motivation: 1)



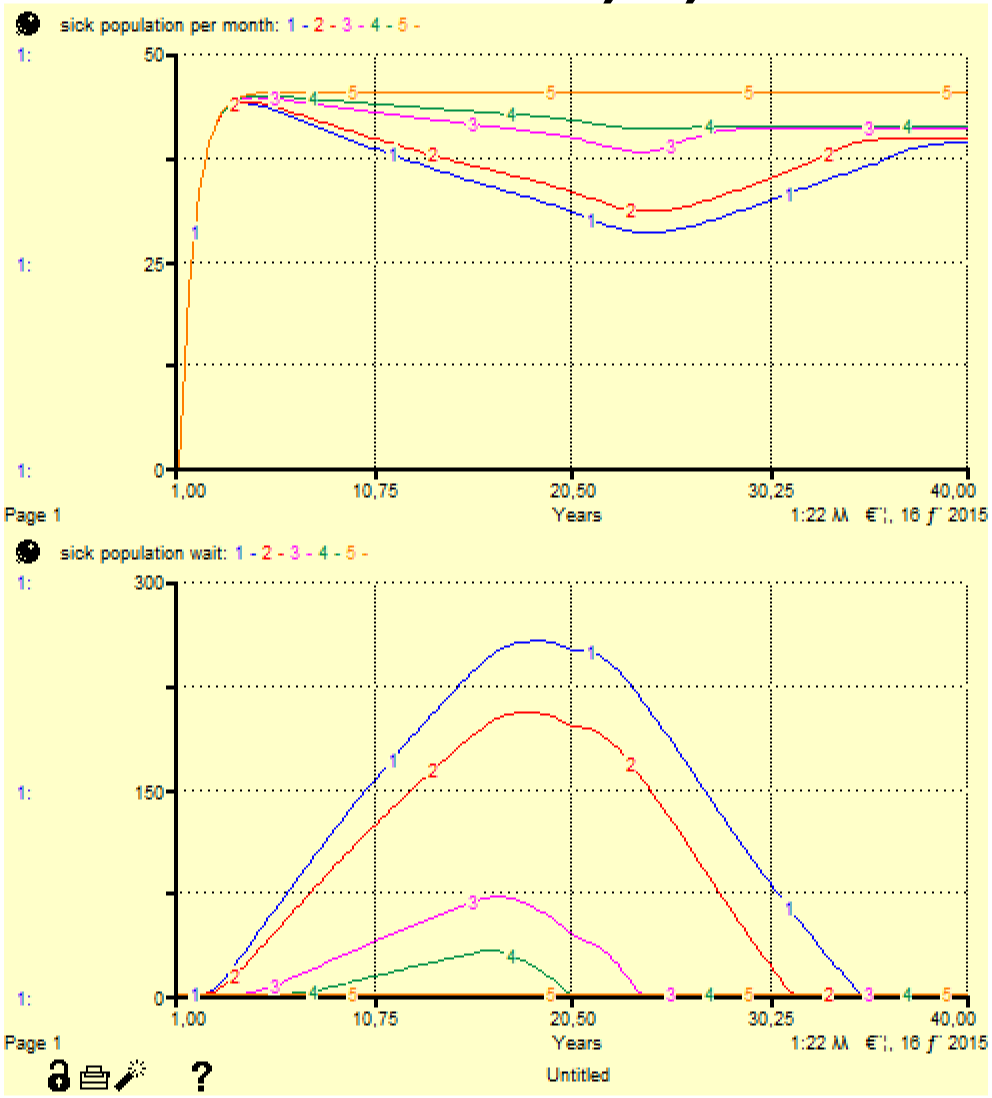
Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1,2; motivation: 1)



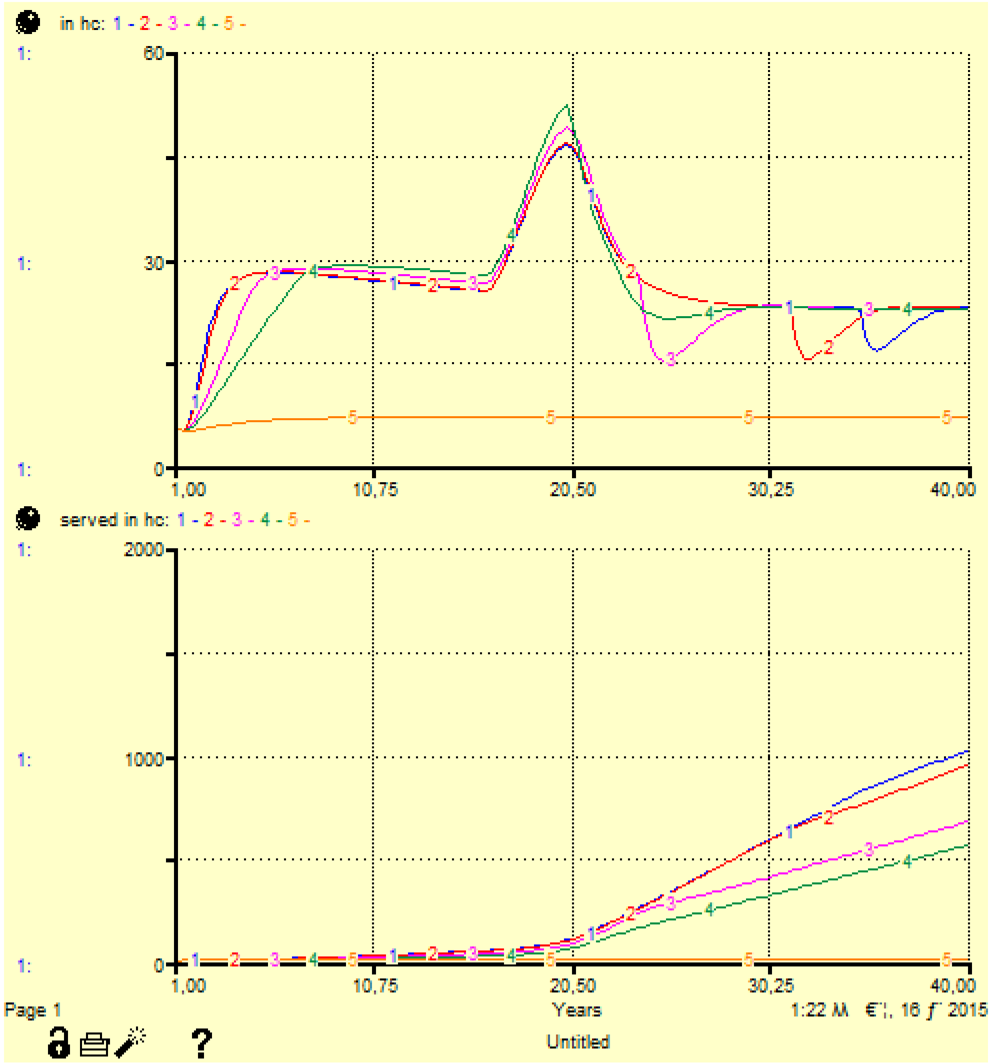
Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1,2; motivation: 1)



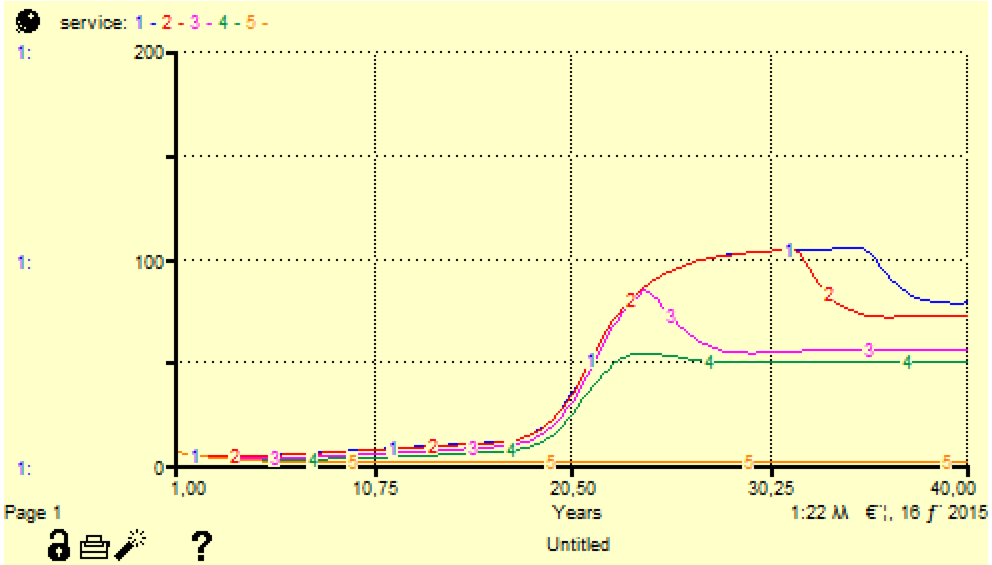
Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1,5; motivation: 1)



Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult value: 1,5; motivation: 1)



Simulations – effect of distance (2,4,6,8, 10 Km) (capacity mult. value: 1,5; motivation: 1)



Further research

- Different motivational profiles (as of *LeGrand, 2005*)
- Different profiles for distance choice, service choice and capacity
- Test sustainability of “optimal” solutions developed by using mathematical programming techniques.