

**STELLA**

**AUTO LEARN GUIDE**

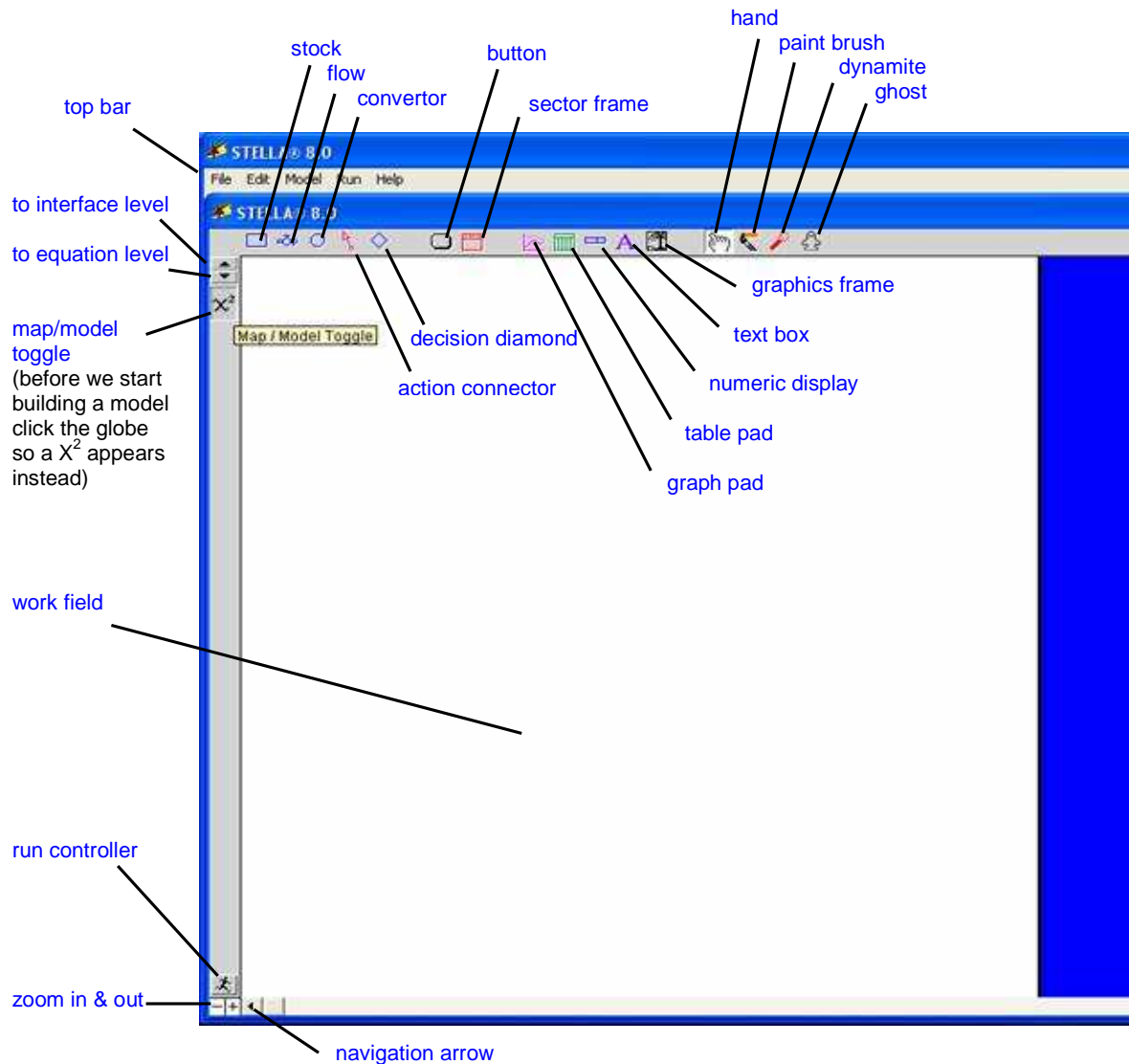
## Before we start building the model

### *Why build a model?*

Building a model can help you get a grip on a complex system. You'll make connections obvious to you visual to others which will help discussing them. You'll be stimulated to think about current trends and project them into the future and discuss how you (CIFOR, WWF, GTZ....) see you could change this future.

### *Some technical terms...*

In the text some technical terms will be used referring to 'buttons' in stella's interface, whenever a term is *italic* just come back to this page to see what it means (they will also become visible when placing the mouse over it on your screen).



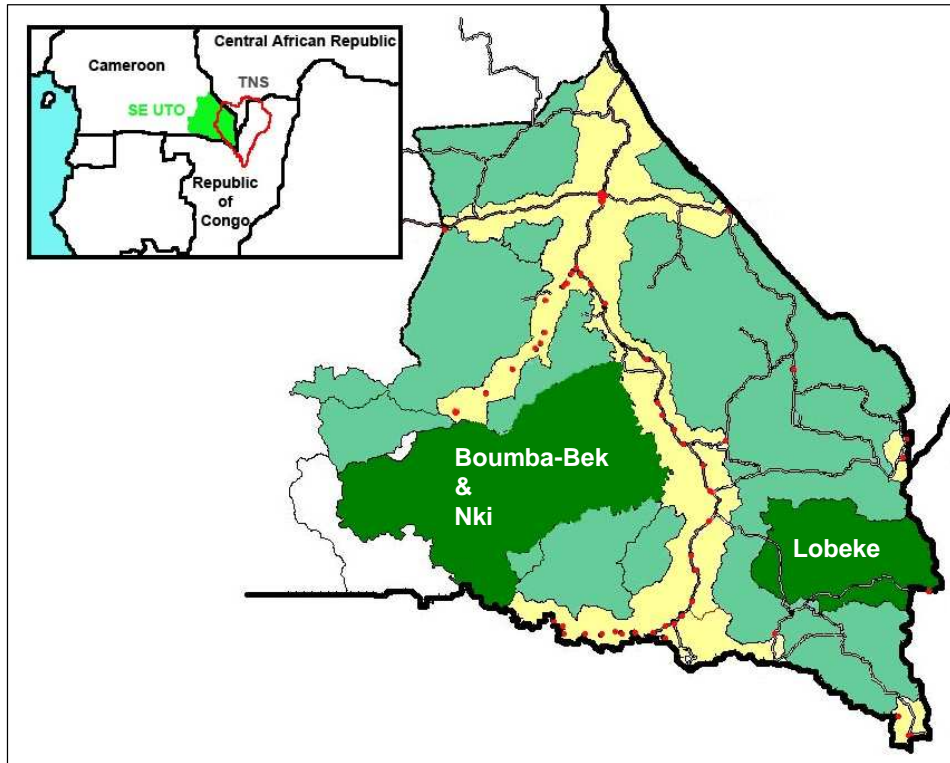
### *Your mission*

You work for WWF in South-East Cameroon and you think family planning is a crucial activity to slow down deforestation. You want to explore the possible impact and discuss with your colleges whether it should become a priority activity on the agenda.

### Information on our landscape

The landscape you work in is called 'UTO Sud Est'. You can see a picture of your landscape in the figure below.

The total area of the UTO SE is 33,600 km<sup>2</sup>. 97% of the landscape is covered with forest and 3% cleared for agriculture (Congo Basin Forestry Partnership, 2005).



Source map: WWF & GTZ 2004

Color in map	Feature	Total surface (in ha)
Light Green	forest concessions	1,759,666
Yellow	agroforestry zone	731,722
Dark Green	national park Boumba-Bek	268,976
Dark Green	national park Nki	378,364
Dark Green	national park Lobeke	218,372

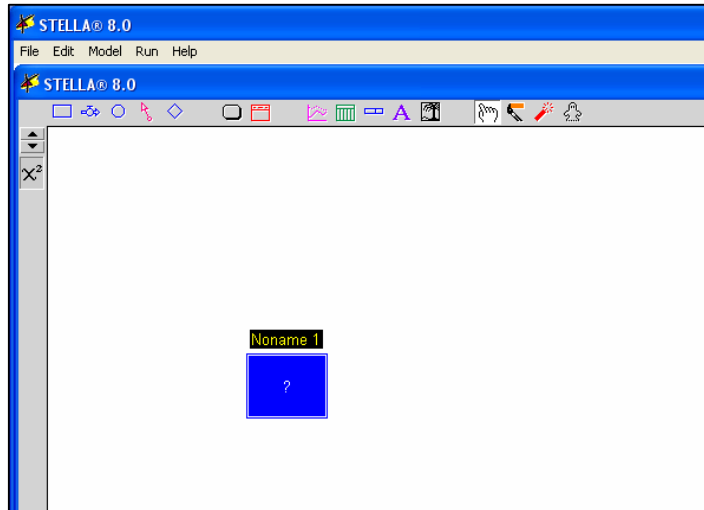
Source: Interactive Forestry Atlas (2004)

To start building the 'land category and land-use dynamics' sector of the model we have to decide what land-use categories have our interest, being careful not to take more details into account than we really need: e.g. for purposes of showing WWF's impact in the UTO SE landscape the category 'land under agricultural cultivation' gives us enough detail and splitting this up in 'land under maize cultivation', 'land under cassava cultivation' and 'land under plantain cultivation' would probably be more detail than actually needed.

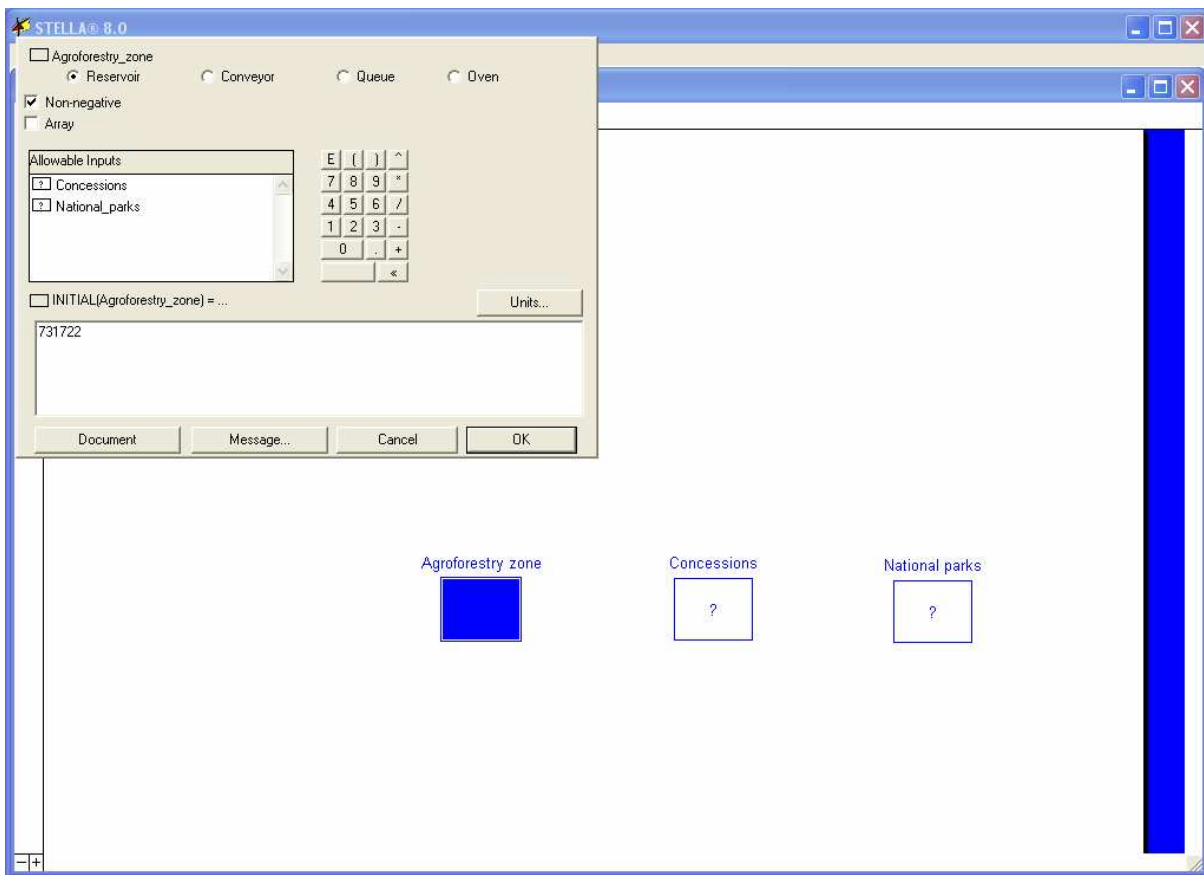
Second, we have to pay attention at all times with building the model to be consistent with our units: as you see in the area information given, the total area is given in km<sup>2</sup> while the different categories are given in hectares. If we decide to use hectares than at all places in the model we should use hectares: e.g. if later we add production of plantain and we know this production per acre than we first need to convert this to production per hectare (2.2 acre = 1 hectare). Let us for the moment choose the land categories 'national parks', 'concessions' and 'agroforestry zone', where we –at least for the moment- do not want to distinguish between the three different national parks, so we will add them under one category of 'national parks'.

## NOW GET STARTED!

Open Stella (Start > all programmes > Stella 8 > Stella 8) and click on the **map/model toggle** (see picture on page 1) so the globe will change in X<sup>2</sup>. Now **click on the stock button** (page 1) and **click again in our work field** (page 1) so we'll have a stock placed as shown in the picture on the right. We now click on 'Noname 1' and **delete this temporary name to type 'agroforestry zone'** in its place. We then **enter 2 other stocks which we name 'concessions' and 'national parks'**.



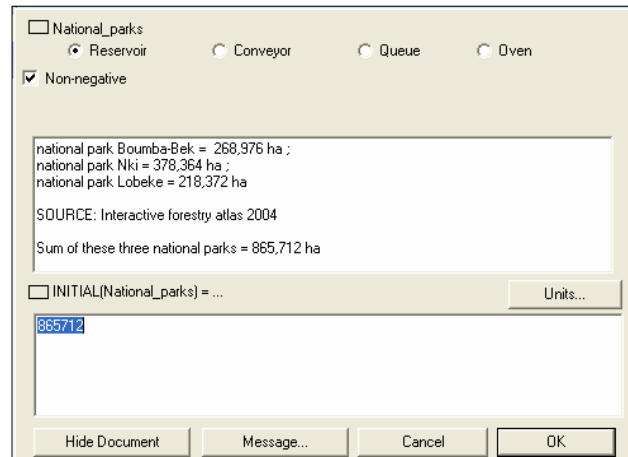
We see in all of our current stocks question marks (?) because we haven't defined their initial value yet. In order to enter the initial value we **double click the stock** after which a window opens as displayed in the following picture:



In this window we **enter the initial value** of 'agroforestry zone' as displayed in the picture. NB pay attention not to put comma's in the value (e.g. 731,722 should be entered as 731722). We decide to use hectares in this model. **Add the initial values of the stocks 'concessions' and 'national parks' as well.**

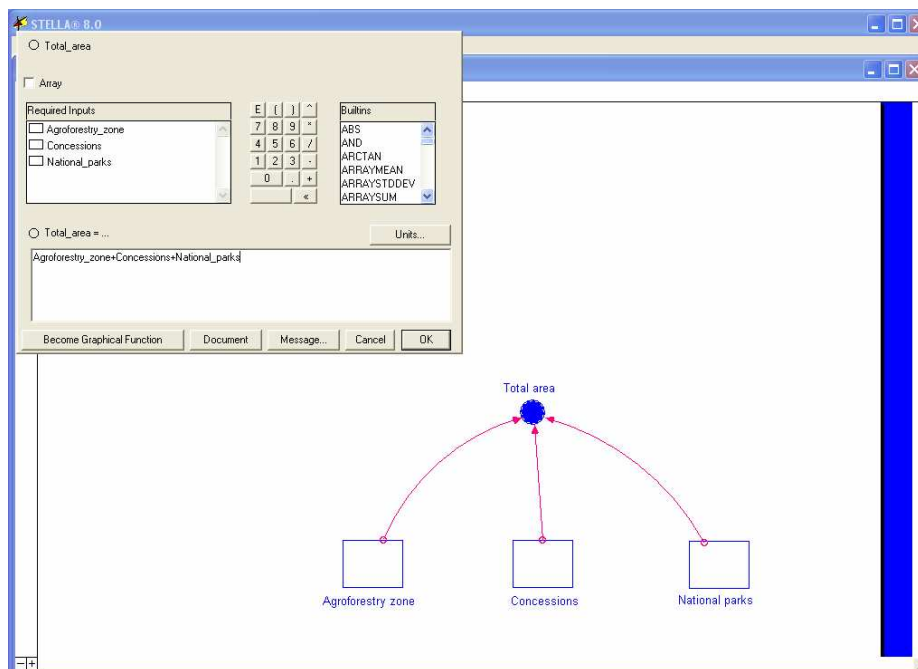
## Enter a document in a stock

It is recommended to always keep track of the source of your information; otherwise after a while you might forget whether information entered was an estimation, older information or data from a recent study. We can add this information by **clicking on the 'document' button** in the window displayed in the previous picture and the picture on the right. In the picture on the right we **explain that 'National Parks' is the sum of three different parks in the UTO SE and we mention the source of this information** (the interactive forestry atlas 2004).



## Entering convertors and a table

We are now going to display our land categories in a table and in this table we would also like to see the total area of the UTO SE. The total land area in our model should not change (land uses can change but the total area does not!) so by summing up all land categories in a *convertor* (see page 1 – the circle) we can check if we didn't make a mistake in the land category model. To do this we **click on convertor and place it in our work field** -for example above the land category stocks- and **name it 'total area'**. We then **draw action connectors** (see page 1 – arrows) **from the stocks to the convertor by first clicking on the action connector button, then clicking on the stock and while we keep the left mouse button pressed, draw it to the convertor till it connects (the convertor will be filled with a colour to show that you connected it)**. Once we connected the three *action connectors*, we **double click the convertor 'total area'** and now see the stocks appear in the window that opens under required inputs (see next picture). We can now **define 'total area' as 'agroforestry zone' + 'concessions' + 'national parks'** as displayed in the following picture:



When we **close the window** we now see no more question marks in the *stocks* or *converter*: all values in the model have been defined and we can now run it. However, do remember we did not define any land categories to be converted into another category so if we run the model now we will see no land use changes because we didn't enter any. Now, **click on the table pad** (page 1) **and place it anywhere in the work field**: the table will open. We now see an empty table with 'time' at the head of the first column: if we run the model here the years of the simulation will be noted. To select the items we want to display in the table, we **double click the first empty column of the table**. Now a window opens with 2 fields: on the left a field called 'allowable' where the items in the model are listed that can be displayed in the table, and on the right a field called 'selected' which is empty for now. We **select 'national parks', 'concessions', 'agroforestry zone' and 'total area' in the 'allowable'-field** and **click on the arrow between the 2 fields after which they are displayed in the 'select'-field**. We then **press ok** and now see these items listed at the head of the columns. **In the top bar (page 1) we select 'run' and then again 'run'** and then see our table is filling up with values, as shown in the picture on the right.

Time	Agroforestry	Concessions	National park	Total area
9.25	731.722.00	1.759.666.00	865.712.00	3.357.100.00
9.50	731.722.00	1.759.666.00	865.712.00	3.357.100.00
9.75	731.722.00	1.759.666.00	865.712.00	3.357.100.00
10.00	731.722.00	1.759.666.00	865.712.00	3.357.100.00
10.25	731.722.00	1.759.666.00	865.712.00	3.357.100.00
10.50	731.722.00	1.759.666.00	865.712.00	3.357.100.00
10.75	731.722.00	1.759.666.00	865.712.00	3.357.100.00
11.00	731.722.00	1.759.666.00	865.712.00	3.357.100.00
11.25	731.722.00	1.759.666.00	865.712.00	3.357.100.00
11.50	731.722.00	1.759.666.00	865.712.00	3.357.100.00
11.75	731.722.00	1.759.666.00	865.712.00	3.357.100.00
Final	731.722.00	1.759.666.00	865.712.00	3.357.100.00

Length of simulation: From: 0 To: 30 DT: 1.00  
 Unit of time: Hours Days Weeks Months Quarters Years Other  
 Run Mode: Normal Cycle-time  
 Interaction Mode: Normal Flight Sim  
 Integration Method: Euler's Method Runge-Kutta 2 Runge-Kutta 4  
 Sim Speed: 0 real secs = 1 unit time  
 Min run length: 0 secs  
 Analyze Mode: stores run results in memory ( 0.0 MB required )

Our total area sums up to 3,357,100 ha, which equals 33,571 km<sup>2</sup> -or rounded up 33,600 km<sup>2</sup>- which is in accordance with the information given on page 2 from the CBFP (2005). Note that the time is displayed in 0.25 year steps in the table and our simulation runs for 12 years. If we want to change this we **select 'run' in the top bar and accordingly we select 'run specs...'** after which a window as displayed in the picture on the left opens. **Fill in the values as in the picture on the left:** the length of the simulation being 30, as time unit select 'years' and as DT or time step enter 1.

Now assume you are interested in the forest cover of the landscape, this is currently not calculated in our model. In our current land categories 'concessions' and 'national parks' are fully covered with forest, while part of our category 'agroforestry zone' is forest and part is land under agriculture. Since we are interested in the total forest cover of the landscape we will thus split our current land category 'agroforestry zone' into 'agricultural land' and 'conversion forest' (or whatever other names that are clearly understandable). Looking again at the information on page 2 we find that the land under cultivation is 3% of the total area, thus we can calculate the value of our new stock 'agricultural land' by:  $0.03 * 3,357,100 \text{ ha} = 100,713 \text{ ha}$ . The rest of the agroforestry zone will be conversion forest, so our new value for conversion forest is obtained by: 'agroforestry zone' - 'agricultural land' or  $731,722 \text{ ha} - 100,713 \text{ ha} = 631,009 \text{ ha}$ .

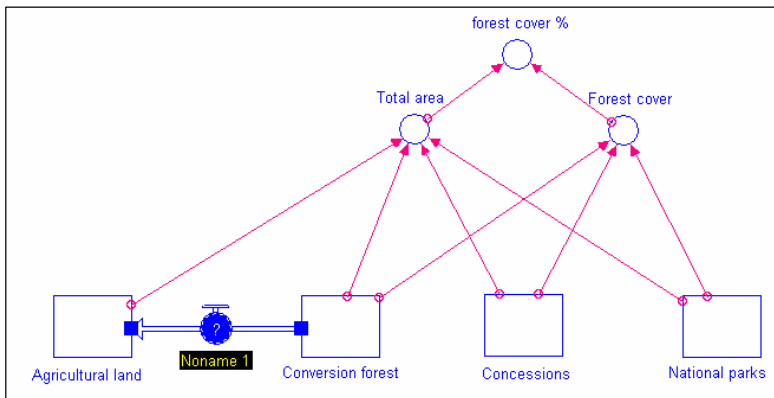
Back to our model: introduce 2 new *stocks*, name them 'agricultural land' and 'conversion forest' and give them the initial values as calculated in the previous paragraph. Since these 2 *stocks* now replace the 'agroforestry zone' *stock*, we will delete it. You will notice that standing on the stock

and pressing the backspace or delete button on your desktop will not delete the *stock* instead, delete it by clicking first on the *dynamite* button (page 1) after which you click on the *stock* 'agroforestry zone' – it will now be deleted. You will notice that when deleting the 'agroforestry zone' stock, also the *action connector* (arrow) going from agroforestry zone to the *converter* 'total area' will disappear and a question mark will appear in 'total area'. To re-calculate the total area we will now draw *action connectors* from our new *stocks* 'agricultural land' and 'conversion forest' to 'total area'. After you have successfully drawn the *action connectors* from the new *stocks* to 'total area' we can double click 'total area' and see 'agricultural land' and 'conversion forest' have appeared in the required input box. In this window we see our old calculation of 'total area' = Agroforestry\_zone+Concessions+National\_parks. We will now delete 'agroforestry zone' and add + agricultural\_land + conversion\_forest. To check if you did this correctly you can run the model again, and look in the table: the total area should still be 3,357,100 ha.

With our current model we can calculate the forest cover of the landscape: total forest cover will be the sum of conversion forest, concessions and national parks. Enter a new *converter* in your *work field* and call it 'forest cover', draw *action connectors* to it from 'conversion forest', 'concessions' and 'national parks', double click on forest cover and define it as conversion\_forest+concessions +national\_parks. We would also like to have forest cover as a percentage of the total landscape. Therefore, enter another *converter* and call it 'forest cover %'. Note that Stella 8.0 does not allow a name to start with a character so the name '% forest cover' will not be accepted. Draw *action connectors* from 'total area' and 'forest cover' to '% forest cover'. Double click on '% forest cover' and define it as forest\_cover/total\_area\*100. We multiply by 100 in order to get a percentage. To control whether you did this correct, you can add '% forest cover' in an empty column in your existing table and run the model: the value should be 97%.

### Adding dynamics to the model: flows

Up to now, our system is not dynamic yet: no values actually change over time in the model we created. This might be correct for 'concessions' and 'national parks', maybe we do not expect the national park area to increase or decrease over time, and maybe we don't expect the forest concession area to change either. But we do expect the agricultural area to change, let us say we expect it to increase and the new agricultural land to be taken from conversion forest. In the model



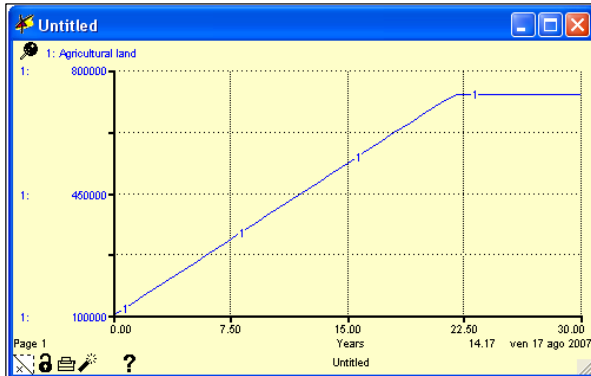
we can add this conversion by clicking on the *flow* button (page 1), bring the mouse to 'conversion forest', click on it and while you keep pressing the mouse button draw it towards 'agricultural land' until it is connected (it will show you it is connected by filling the *stock* with a colour). Your model should now look like the picture on the left.

We can call the *flow* for example deforestation or conversion of forest to agriculture. Now we have to define our *flow*. We don't know exactly at what rate forest is converted into agricultural land for the UTO SE landscape, but as a start we can use national data and later change it to approach the situation in the South East of Cameroon. In a World Bank environment report (2004), we find that the national deforestation rate for 2000 was 0.89%. Using the same rate for our landscape, this percentage would translate into  $0.89/100 * 0.97 * 3,357,100\text{ha}$  (forest cover of UTO SE) = 28,982ha. So let us for now use this fixed amount of forest to be converted into agriculture per year: double click on the *flow* and fill in 28982 in the window. Also click on 'document' and explain how you

calculated this amount and give the source of your 2000 deforestation rate for Cameroon (World Bank environmental report, 2004).

### Entering a graph

Now we would like to see what happens with the agricultural land in our model and this time we will

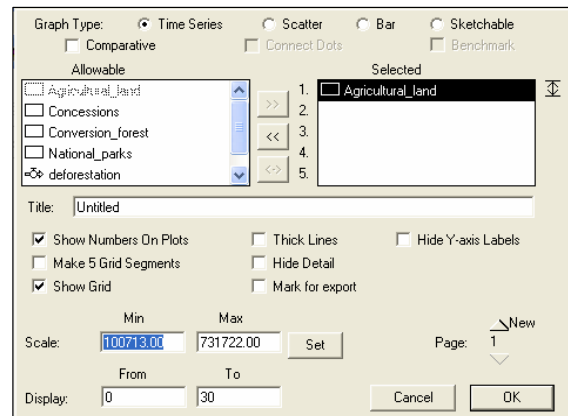


not use a table to display the model's outcome but a graph: click on *graph pad* (page 1) and click again somewhere in your *work field* to deposit a graph which will open immediately once you've placed it. To select the features you want to show in the graph double click on the Y-axis. Click under 'allowable' on 'agricultural land' and move it to 'selected' by clicking on the arrow in between the 2 windows and click ok. Now select 'run' on the *top bar*, and again 'run': you will now see the output graph of agricultural land appear in your graph pad like in the picture on the left.

### Setting the scale of the graph

Note that the scale on the Y-axis is not starting from 0 but from 100,000. To change this, double click on the Y-axis again, click once on 'agricultural land' and click on the double arrow on the right of 'agricultural land' so it will be enclosed by horizontal lines as in the picture on the right. You can now enter the minimum and maximum value of your scale in the left below corner. Enter 0 under 'min' and 750,000 under 'max', click on set and click ok. The scale in your graph is now going from 0-750,000.

Now look again at the graph and note that after 22 years the agricultural land does not expand anymore but remains at 731,722 ha. Look again at your model and explain why this happens.

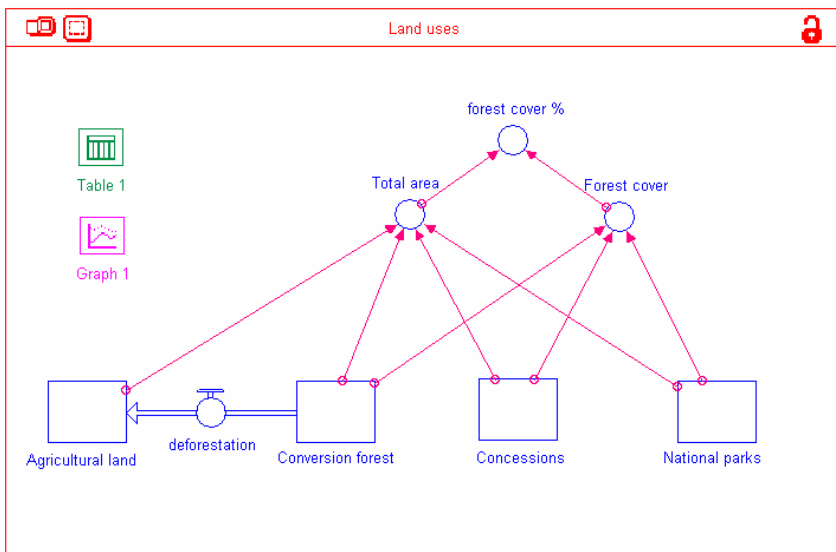


### Reality check

Whenever we create a new dynamic in our model, like the conversion of 'conversion forest' into 'agricultural land', it's good to display the calculated feature in a graph and do a reality check: do we really think all conversion forest in the UTO SE landscape will be converted into agricultural land in 22 years from now? People working in the UTO SE would probably tell you this is not likely to happen. To better understand the deforestation dynamic we just modelled as a static conversion amount per year, we should ask people who know this landscape what the actual driving factors are behind this conversion. They would probably mention 'population growth' and 'construction of roads' as some of the factors driving the expansion of the agricultural land area. The population density in the South East of Cameroon is much lower than for example in the South-Centre or South-West of the country, so our calculated conversion quantity based on the Cameroonian deforestation rate is probably higher than realistic in the South-East. If we want to make the conversion of forest into agriculture a function of human population dynamics we should add this as a new sector to our model.

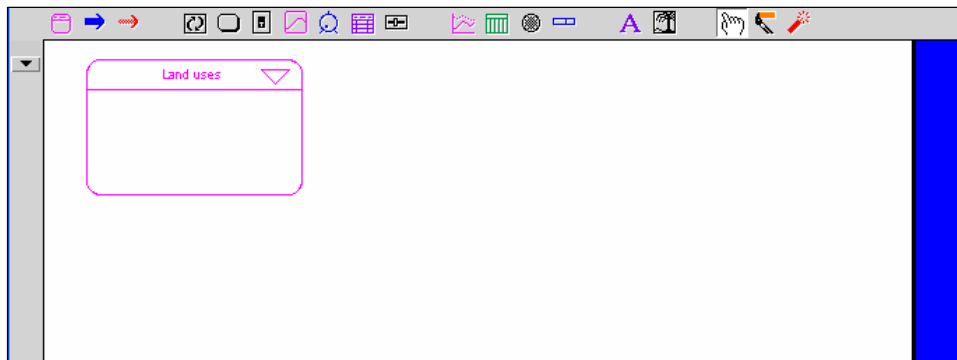
## Define a model sector

But let us first define the current sector we have been working on. Click on the button sector frame and place it over the *stocks* and *convertors* in then *work field* we have created so far and pull the



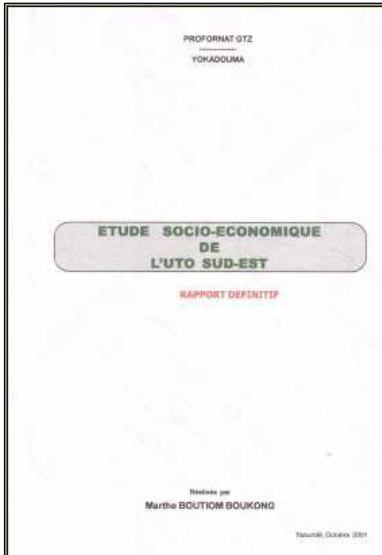
corners so that all elements of our current model are fitted in the *sector frame*. Now click on the *to interface level* button and click on 'Interface' in the *top bar* after which you select 'Interface prefs...'. In the window that now opens you check the box 'Link High-Level Map to Model' under 'interface options' and click ok. You now see that the sector 'land uses' is displayed in the interface level's work field as shown in the picture below. In the upper right corner of land

uses *sector frame* we see an up-side-down triangle. When clicking on this triangle we return to the map/model level *work field* where we were before. We see that in this *sector frame* now also a triangle appeared in the upper right corner, when clicking scales us back up to the interface level again. This will make it easier to navigate through the model once we have more sectors in it.



## Add a new sector: population dynamics

So we expect the conversion of forest into agricultural land to be driven by the human population, and we expect human population not to remain a fixed number throughout our simulation. Therefore, we first will add human population dynamics in a new sector for our model, before correcting our deforestation *flow* in the land uses sector. We can call our new sector 'population dynamics' for example. Go to the map/model level and move a bit right of the land uses sector with the *navigation arrows* (page 1). Click on the *sector frame* button and deposit the new sector frame to the right of the land uses sector, if this area is blue (outside your work field) just placing the frame on the blue will automatically expand your work field so it will turn white. Name the frame 'population dynamics'. Now we need some values on population dynamics so before we continue we would search a population census report.



We find this socio-economic study (cover left and table below) dating from 2001 as only document with demographic information for the UTO SE as follows:

Total population in 2000 = 140,810 people  
 Birth rate = 0.0522 ;  
 death rate= 0.0128 ;  
 population growth rate= 0.038

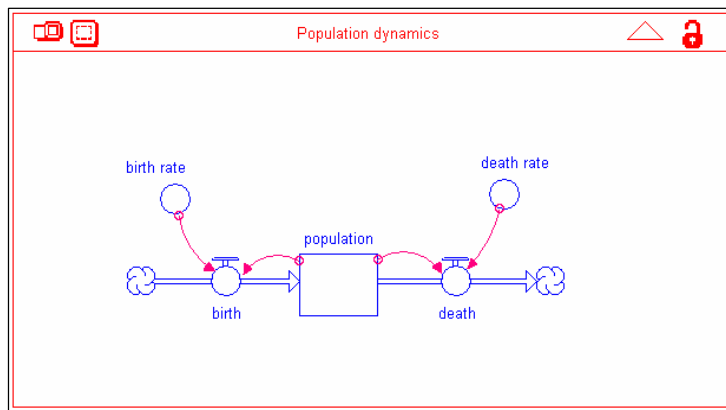
Considering the population growth rate would remain 3.8% until 2007 this means the total population should now be around 176,123 people.

Let's start building the model now. Draw a *stock* into the new population dynamics *sector frame* and call it 'population', double click on it and give it the value 176123, click on the document

button and explain how you got this information (2001 census data from GTZ, corrected for the total UTO SE area and extrapolated to the year 2007 using the reports growth rate for the region).

Now we have a static population but we are interested in dynamics. So we will add birth and death. In a population where there is no immigration nor out migration or where the number of people immigrating is exactly the same as the number of people out migrating, the population growth rate should equal the birth rate minus the death rate. As you are knowledgeable about your landscape you think the number of people immigrating is about the same as the number outmigrating. Click on the *flow* and click again in the *workfield* on the left side of the *stock* called population, don't stop pressing the mouse button. Now move the cursor towards the stock so the flow will go into the stock. If you did not succeed, the *flow* will be floating in your *workfield* and you'll have to delete it using the *dynamite* button. Call the inflow 'births'.

After this, put in another *flow* now going out of the *stock* population and call it 'deaths'. Enter a *connector* next to the inflow and call it 'birthrate', give it the value 0.0522 and mention the source in the document. Enter another *connector* next to the outflow and call it 'mortality rate', give it the value 0.0128. Now draw action connectors from 'birth rate' to the inflow and from 'population' to the inflow and define the inflow as 'birthrate' x 'population'. Do the same for death rate.



### Reality check

Now look what happens with your population over time in a graph (pull in a graph, select population on the Y-axis, and run a simulation). Mind the scale! Is this what you expect to see happening in the future? Yeah, more or less.

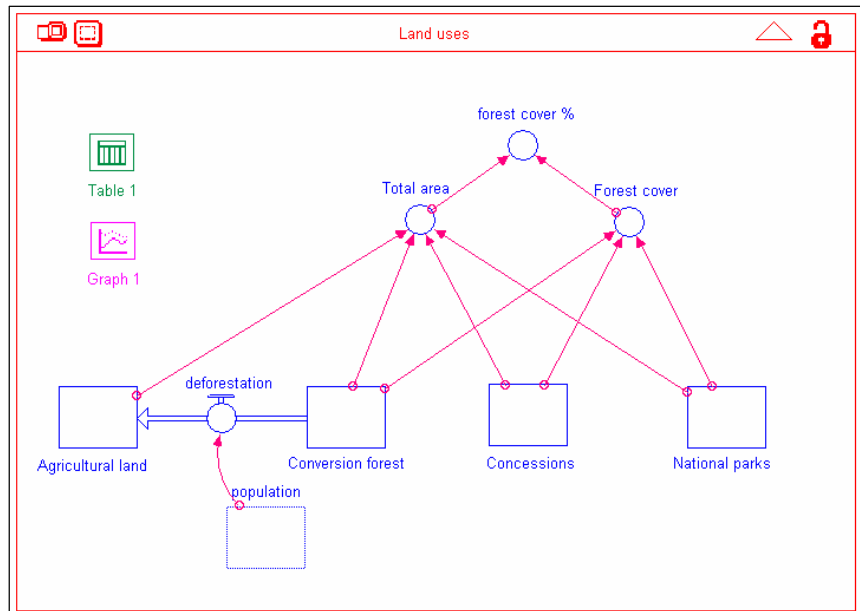
### Linking different sectors

As we said before, we think deforestation in the landscape is mainly driven by population growth so that's what we will now model.

Click on the *ghost* button and click after that on 'population', you have now copied the population stock and can drop it near the deforestation flow. Draw an action connector from the ghosted stock population to the deforestation flow.

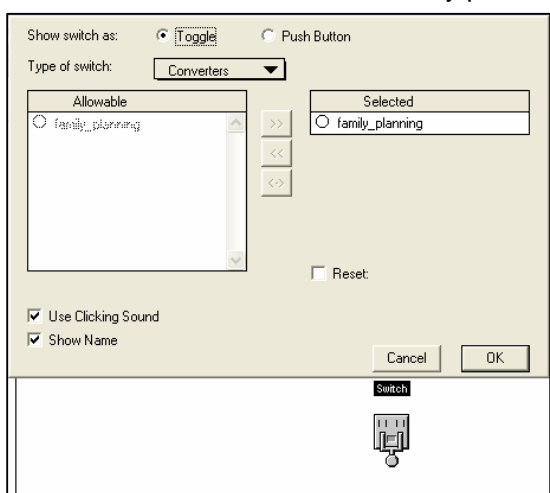
Instead of using the earlier calculated value for deforestation of 28,982 ha per year, we will now make this a function of population. Now we'll calculate the 'deforestation per person' and multiply that by the total population. Deforestation per person would be  $28,982/176,123 = 0.1645$

ha/person. So now double click on the flow called deforestation and define it as  $0.1645 \times \text{'population'}$ . Open your graph with agricultural land and run a simulation. Do you see a different graph? Do you think it's realistic what you're seeing?



### Your impact

Now we want to get to the point where you'll show your expected impact. You think that with your family planning programme, you can reduce the birth rate from 0.0522 to 0.04. Place a *converter* next to the births flow, name it 'family planning' and give it the value 0.



Draw an *action connector* from 'family planning' to 'birth'. Your birth inflow was defined as 'birth\_rate' x 'population', now change the definition of 'birth' to 'if family planning=0 then birth rate\*population else 0.04\*population'. Now click on the triangle in the upper right corner to go to the interface level. You will see now a big red arrow has appeared going from your population dynamics sector to your land uses sector. This arrow shows us that an element calculated in the population dynamics sector is used to calculate another element in the land uses sector. Now click on a button called 'switch' in your upper bar. Place the switch somewhere in your *workfield*. Double click the switch you just deposited so the window as shown on the right appears and move 'family planning' from allowable to selected as shown in the picture.

Now deposit a graph next to your switch and pin it on the *workfield* by clicking on the pin in the upper left corner. Check the box comparative and select (by double clicking the Y-axis) 'forest cover'. Now run a simulation with the switch off and one with the switch on. Look at your graphs, are you surprised? You can also make a comparative graph showing 'population' under the no family planning and family planning scenario to help you understand what happened in your simulation.