Dealing with Multiple Perspectives: Using (Cultural) Profiles in System Dynamics

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Abstract

Many important dynamically complex issues are also characterised by a large number of actors with different world views, value systems, lifestyles, perspectives, interests, resources, and goals. One way to deal with this diversity in System Dynamics modelling –without modelling only one, or at the other extreme, all possible perspectives– is to use a set of different profiles to represent different groups of actors, and/or their perspectives.
Profiles could be used in at least three ways in System Dynamics modelling: (i) to provide different profile-dependent parameters and objectives to be applied separately to the same System Dynamics model; (ii) to model different groups of agents with different profiles within one and the same System Dynamics model; and (iii) to build different System Dynamics models for different profiles.
Several useful sets of profiles have already been proposed –and are frequently used– in other domains. In this paper, a set of four different profiles, derived more precisely from Cultural Theory (anthropology), is used to illustrate the application of profiles in System Dynamics modelling. The specific application domain dealt with, is the (re)development of peripheral –formally social housing– districts in Dutch cities into attractive residential districts consisting of mixed social and private housing.

Keywords: Multiple Perspectives, Profiling, Cultural Theory, System Dynamics, Development of Residential Areas

1 Introduction

1.1 Multiple Perspectives on Systems to Deal with Multi-Actor Systems

Many important dynamically complex issues –so-called Multi-Actor Systems (MAS)– are characterised by *system* aspects, by *multi-actor* aspects, and their combined effects. System Dynamics modelling has traditionally been focussed on the *system* part of Multi-Actor Systems: complex real-world actors have mostly been included as homogenous agents –if included at all– in aggregated System Dynamics models.

In recent years, System Dynamics modellers have started to put more emphasis on actor representation, agent heterogeneity, and multi-agent complexity. In some instances, different System Dynamics models are developed to represent and simulate the same system from different –sometimes even incompatible– points of view without explicitly representing individual actors by means of agents in the model (see for example (Pruyt 2006)). In other cases, Agent Based System Dynamics Models are developed to represent very large numbers of individual actors within the system by means of –often rather simplistic– software agents, which, together, generate emergent behaviour at the system level. The degree of heterogeneity of the agents modelled in these Agent Based Models is often situated at the other extreme (each actor represented by an agent).

Although the inclusion of actors and actor heterogeneity might be useful, sometimes even necessary, too many actors and too much actor heterogeneity might also be undesirable. Rahmandad and Sterman (2008) and Yucel and van Daalen (2008) –investigating the influence of the degree of agent heterogeneity– conclude i.a. that introducing more heterogeneity might lead to higher costs in terms of verification/validation, and to problems of reduced understanding and fewer insights generated.

An intermediate degree of actor heterogeneity might in many cases be more useful. The question addressed in this paper is therefore: how could System Dynamics be applied to deal with Multi-Actor Systems that are characterised by *some* actor complexity, resulting from the behaviour of different groups of almost similar actors, without immediately representing all individual actors?

In this paper, it is proposed to use different *profiles* to represent several (heterogenous) groups of (homogenous) actors: world views, value systems, lifestyles, interests, and perspectives differ between agents belonging to different profiles, but are shared by agents belonging to the same profile. It will be shown in this paper that these profiles could be used to *(i)* simulate the same System Dynamics model for different profiles, or to *(ii)* simulate different groups of actors simultaneously in one and the same System Dynamics model, or to *(iii)* construct different System Dynamics models, each corresponding to a profile (with or without agents with different profiles explicitly modelled).

1.2 Organisation

Section 2 deals with the concept 'profile', possible uses of profiles, and the profiles proposed by Cultural Theory. Three different uses of these profiles in System Dynamics studies are illustrated in section 3: the issue dealt with, is the (re)development of (former) social housing districts in the Netherlands. Concluding remarks are formulated in section 4.

2 Profiles

2.1 Definition and Uses of Profiles

What are profiles? Profiles are distinctive, recognizable, and consistent descriptions of world views and/or lifestyles that could be used to represent groups of people with more or less the same world views and/or lifestyles. Profiles average over groups of rather similar individuals. Hence, they are always simplified, imperfect, and sometimes rather caricatural.

Generally speaking, it could be said that the use of different profiles allows:

- to consider, analyse, model, investigate, illustrate, and communicate the implications of outlined world views, value systems and life styles, without considering, analysing, modelling and communicating all slightly different points of view of all actors.
- to take value diversity –an important source of uncertainty often neglected by System Dynamicists (Pruyt 2007)– explicitly into account, and related to this, avoid the trap of pursuing the development of 'the correct' model by considering a single perspective.
- to find overlooked options and construct culturally hybrid policy alternatives (Hoppe 2007).
- to test the robustness of policy recommendations for different world views, value systems and life styles, before they are proposed to groups of decision-makers and/or the public. This might be important for public policy makers, for reasons of policy continuity (will the policy be reversed by the next government) and political and public support (are the proposed

policies supported by other policy-makers and/or the public). It might also be used to check for political and public support in situations where public debate is impossible[1].

Hence, profiles might be used in System Dynamics studies to structure problems and frame analyses, to break away from one own's perspective and learn about other perspectives, to recognise and deal with value diversity, to anticipate side effects related to actor perspectives and responses, to find overlooked options and construct culturally hybrid policy alternatives, and finally, to avoid analyses in terms of political party politics.

2.2 Other Profiles

Problem-specific profiles could be developed for every Multi-Actor System issue by means of multi-variate clustering or related techniques. However, many 'off the shelf' sets of profiles are also discussed in the literature of domains such as anthropology, sociology, psychology, policy science, and (direct) marketing.

Cultural Theory, developed in anthropology and used in this paper, provides one possible set of profiles that could be used to take this diversity explicitly into account in System Dynamics modelling. It should be emphasised, that the profiles developed in Cultural Theory are just one among many different sets of profiles that might be used to increase agent heterogeneity within System Dynamics modelling.

2.3 Profiles Described in Cultural Theory

Cultural Theory is a theory that was initially developed by Douglas and Wildavsky (1982) and Wildavsky, Thompson, and Ellis (1990) that has become rather popular in anthropology and policy sciences, in part because of its intuitive appeal, but which is still controversial outside of these domains[2]. They argue that social structures differ along two principal axes:

- the *grid*: degree to which individuals' choices are circumscribed by (their position in) society;
- the *group*: degree of solidarity among members of that society.

Combining *group* and *grid* leads to four main profiles (the *individualist*, the *egalitarian*, the *hierarchist*, and the *fatalist*), and 1 subordinate profile (the *autonomous hermit*, which is not described here, because it is mostly of marginal importance).

These profiles could be linked –as proposed in (MNP/RIVM 2004; Beckers et al. 2004; MNP/RIVM 2005)– to the four archetypical scenario world views of the IPCC (Nakicenovic et al. 2000) (see right hand side of figure 1), and other lifestyle typologies and/or value classifications, such as the WIN-model, which consists of 8 value orientations (see left hand side of figure 1). The four resulting profiles could then be summarised as follows:

- *Individualists* (low *grid* and low *group*) feel unconstrained by rules and the group. They value individual initiative, believe in free markets, view nature as being resilient, and embrace trial-and-error, as they are confident that the system will fix itself in the end. If linked to the IPCC world views, then *individualists* might be associated to the '*global market*' world view ('A1'). This profile mainly consist of 'professionals' (zakelijken), part of the 'luxury seekers' (luxezoekers), and some of the 'broad-minded' (ruimdenkers) of the WIN typology.

[1] An example of the use of profiles to take value diversity explicitly into account when open discussion in public fora is impossible, is the Dutch National Risk Assessment, which is part of the Dutch National Safety and Security Strategy (see (Pruyt and Wijnmalen 2008; PNV 2007)). Five profiles, based on Cultural Theory, are used in the NRA (in stead of a single profile of 'the decision-maker') to assess the impact of different risk scenarios (both malicious and non-malicious). These profiles are aligned with (and assumed to correspond to) the preference profiles of different types of policy-makers who represent different sections of society that are characterised by different world views and lifestyles. These different profiles are mainly used in the NRA to test the representativity and policy robustness of the policy recommendations given this set of profiles, and hence to evaluate these options taking value diversity into account. It should however immediately be emphasized that using profiles could support democratic processes, but that using profiles should not be intended to *replace* democracy.

[2] Much debate still surrounds attempts to empirically validate Cultural Theory.

- *Egalitarians* (low *grid* and high *group*) are unconstrained by rules but are constrained by the group in which everyone ought to be equal. Egalitarians are solidary, see nature as fragile, advocate the precautionary principle and traditional/sustainable ways of living. If linked to the IPCC world views and WIN lifestyle typology, then '*egalitarians*' might be associated to the '*global solidarity*' world view ('B1') and mainly consist of the 'engaged' (geëngageerden), and most of the 'broad-minded' (ruimdenkers).

- *Fatalists* or *isolates* (high *grid* and low *group*) obey the rules imposed on them, but do not feel as if they are really part of society. Hence, they feel as if they cannot control their own fate. If linked to the IPCC world views and WIN lifestyle typology, then '*fatalists*' might be associated to the '*safe region*' world view ('A2') and mainly consist of 'sensualists' (genieters), part of the 'conservatives' (behoudenden), and some of the 'luxury seekers' (luxezoekers).

- *Hierarchists* (high *grid* and high *group*) feel constrained by rules and the group: members of society need to have well-defined roles and systems should have well-defined rules. They rely heavily on experts/authority and assume that nature is exploitable within certain limits. If linked to the IPCC world views and WIN lifestyle typology, then '*hierarchists*' might be associated to the '*caring region*' world view ('B2') and mainly consist of the 'caring' (zorgzamen), and part of the 'conservatives' (behoudenden).

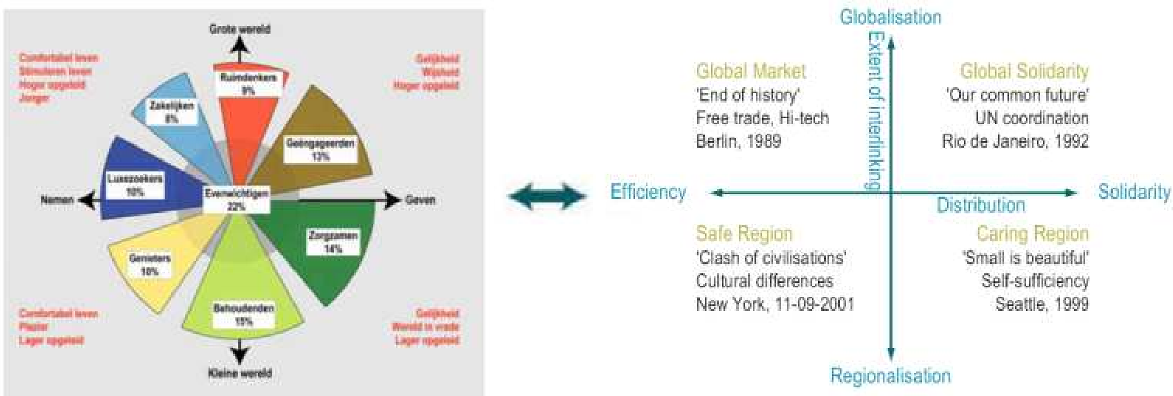

Figure 1: ***Left:*** value orientations of the WIN model. Source: MNP/RIVM (2004). ***Right***: four world views from the IPCC. Sources: (MNP/RIVM 2004) and (MNP/RIVM 2005, p8)

3 Application: (Re)Development of Social Housing Districts in the Netherlands

In the current section, different uses of profiles in System Dynamics will be illustrated. The profiles are based on the profiles described in subsection 2.3. It should however be clear that these profiles are only used for illustrative purposes, and that other sets of profiles might have been used equally well.

3.1 The Issue: (Re)Development of Residential/Peripheral Districts in the Netherlands – The Agnetapark

Many of the peripheral quarters or residential districts in the Netherlands were –and still are– constructed in their entirety by (social) housing corporations. Many of these districts gradually deteriorated over time and currently need to be redeveloped. Different redevelopment options are chosen, among else depending on the characteristics of the districts in question: some districts are (partly) demolished and rebuild, some districts are entirely renovated, some districts are gradually privatised in order to bring about a healthy mix of (social) tenants and home-owners (owning the home in which they reside) and to generate the necessary revenues to renovate the social housing fraction, et cetera. However, any of these option chosen leads to complex dynamic behaviour over time that needs to be investigated before the choice is actually made: the future development of the districts in terms of the mix of inhabitants, the quality of the housing, etc., crucially depends on the redevelopment option chosen. System Dynamics could be used to investigate this dynamic complexity.

One such district, the 'Agnetapark' in Delft, will now be briefly discussed, since it will serve as 'model district' in the remainder of the paper to illustrate the use of profiles in System Dynamics.

The Agnetapark in Delft is a garden village. The oldest part was built between 1884 and 1886, based on plans of the visionary director of the Nederlandse Gist- en Spiritusfabriek, Mr. J.C. van Marken. The more recent part was built round 1930. The houses are surrounded by a park-like environment (see Figure 2). Marken wanted to offer his factory workers proper and functional housing. This resulted in loyal workers and a low degree of absenteeism. Before 2006, all houses and apartments in the Agnetapark were rented to (former) employees or to tenants in the social market.

(a) Green park-like environment (b) Small apartments in 'house style' (c) New, non-local inhabitant

Figure 2: Pictures of Agnetapark in Delft (Source and featuring: ir. H.S.I. Vreugdenhil)

The quarter itself is very nice: it is even protected as a national monument. However, the individual houses and apartments are –even for Dutch standards– very small. The houses are also old, and have not been refurbished on the inside. Moreover, the quality of the housing will never come near the quality of newly built housing, even if completely refurbished, among else because of restrictions related to the status of national monument.

The majority of the non-proprietary inhabitants were –and still are– at an advanced age and can take advantage of a low rent, about half the price paid on the private renting market.

In order to redevelop the Agnetapark, it was decided that all houses and apartments becoming free of occupancy from 2006 on, would be sold on the private market. The majority of the new proprietary inhabitants are young couples, typically double income without kids. This might however be a short term effect. But what will the long term effect be? Or in other words: what will be the resulting dynamic consequences of such choices in the long term for these neighbourhoods?

3.2 Homogenous Agents in a Single Model

In this section, the basic System Dynamics simulation model –which could be used to study redevelopment cases such as the Agnetapark– will be introduced. Profiles will not be used, which means that the model will be simulated from one point of view, containing only two types of –fully homogenous– agents (autochthonous families and autochthonous families).

3.2.1 The System Dynamics Model

The basic model consists of two views: a 'family view' to capture the dynamics of the inhabiting families, and a 'housing view' to capture the dynamics of the housing stock (see figure 3).

The family view: *Local Families* can only stay or leave. The *Outflow of Local Families* is a function[3] of the *Perceived Quality of Life by the Local Families* times the *Local Families* divided by the *Stickiness of the Local Families*. The *Perceived Quality of Life by the Local Families* is the sum of the *Social Cohesion*, the *Quality of the Own Apartment*, and the *Quality of the Neighbourhood*, weighted by their relative *Importance*[4]. Almost the same goes for *Non-Local Families*: they also leave in function of their *Perceived Quality of Life*. However, their *Perceived Quality of Life* is the sum of the *Social Dominance of Non-Local Families* (instead of the *Social Cohesion* as in case of the local families), the *Quality of the Own Apartment*, and the *Quality of the Neighbourhood*, weighted by their relative *Importance*.

The housing view: *Social Market Apartments* are privatised pro rata the *Outflow of Local Families*: after *Privatisation*, these apartments become part of the *Private Market Apartments* stock. Separate stock-flow structures keeps track of the quality of the apartments. The quality of the apartments decreases through *Aging of Social Market Apartments* and *Aging of Private Market Apartments*, according to their respective *Lifetime Without Refurbishment*. The quality of the apartments can also be increased through *Refurbishment of the Social Market Apartments* and *Refurbishment of the Private Market Apartments* respectively. However, the maximum fractions of refurbishment are limited. The *Average Quality of Social Market Apartments* and the *Average Quality of Private Market Apartments* in turn influence the *Perceived Qualities of Life* in the 'Family view'.

Parameter values and lookup function: Initially the *Number of Social Market Apartments* is 200, that of the private market 40. The *Average Quality Social Market* initially equals the *Average Quality Private Market* of 70%. Both the social and private market apartments have a *Lifetime Without Refurbishment* of 30 year.

The *Maximum Fraction of Refurbishment* of social market apartments is assumed to be 90%, that of the private market apartments 95%. The *Fraction of Private Market Apartments Being Refurbished* is at any moment 15%. The social market apartments are assumed to be refurbished in block every 25 years between 2005 and 2009 (20% per year), and between 2030 and 2034 (20% per year).

The perceived quality of life of local families is linked, in this basic model, to their outflow by means of the lookup function[5] displayed in Figure 4a. The perceived quality of life of non-local families is linked to their outflow by means of the lookup function[6] displayed in Figure 4b. And the variable *Social Dominance Non-Local Families* also contains a lookup function[7] displayed in figure 4c.

Local and non-local families are assumed to attach a relative weight of 32% to *Importance Social Cohesion*, a relative weight of 40% to *Importance Quality of Neighbourhood for Local Families*, and a relative weight of 28% to *Importance Quality of Own Apartment for Local Families*.

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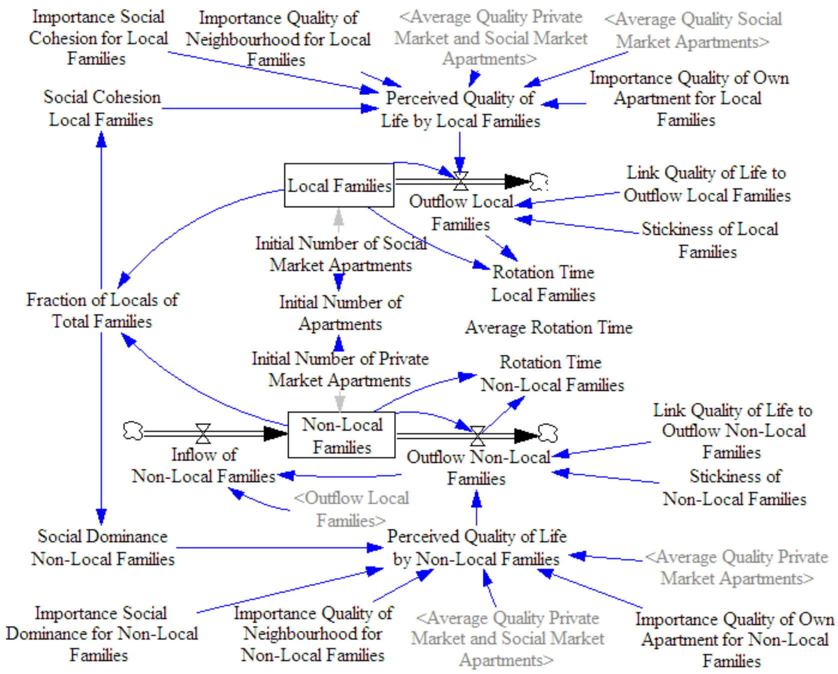
[3] More precisely the function *Link Quality of Life to Outflow Local Families*, which is a lookup function.

[4] *Perceived Quality of Life by Local Families* = (*Importance Social Cohesion for Local Families * Social Cohesion Local Families + Importance Quality of Own Apartment for Local Families * Average Quality Social Market Apartments + Importance Quality of Neighbourhood for Local Families * Average Quality Private Market and Social Market Apartments*) / (*Importance Quality of Neighbourhood for Local Families + Importance Quality of Own Apartment for Local Families + Importance Social Cohesion for Local Families*)

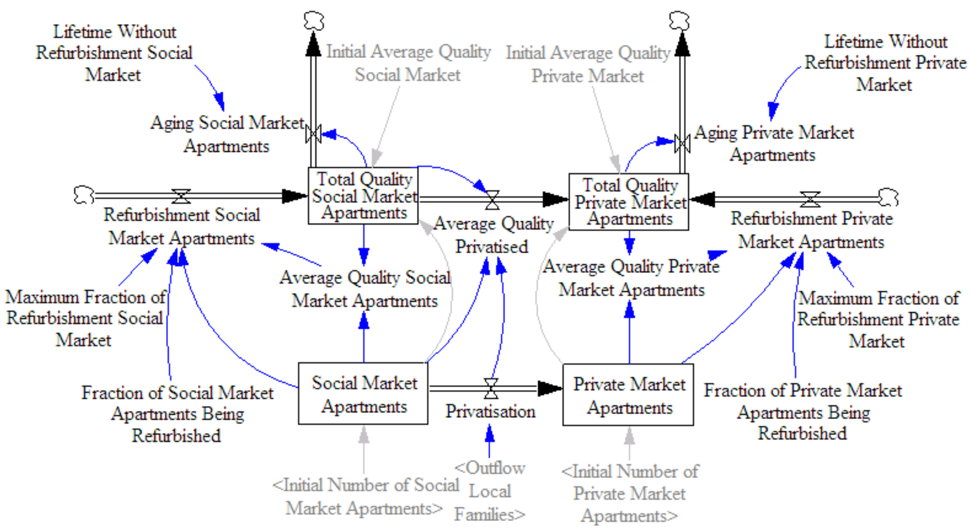
[5] *Link Quality of Life to Outflow Local Families* = LOOKUP((0,0.8), (0.2,0.5), (0.5,0.2), (0.8,0.05), (1,0), (2,0))

[6] *Link Quality of Life to Outflow Non-Local Families* = LOOKUP((0,1),(0.2,0.9),(0.5,0.5),(0.8,0.1),(1,0), (2,0))

[7] *Social Dominance Non-Local Families* = WITH LOOKUP(Fraction of Locals of Total Families, ((0,1), (0.2,0.8), (0.5,0.5), (0.8,0.2), (1,0)))

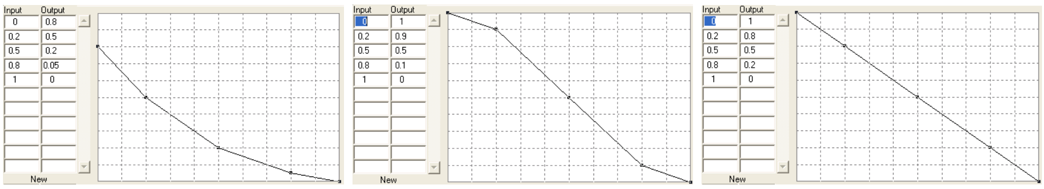


(a) The 'family view'



(b) The 'housing view'

Figure 3: Stock-Flow Diagram of the basic System Dynamics simulation model



(a) Link Quality of Life to Outflow Local Families (b) Link Quality of Life to Outflow Non-Local Families (c) Social Dominance Non-Local Families

Figure 4: Three Lookup Functions Used in the Basic SD Model

Local families are rather sticky –a *Stickiness* of 4.7 is assumed. This means that only 1 out of 4.7 local families that should –based on their quality of life– be moving out of the district, actually do so. A lower *Stickiness of Non-Local Families* of 3.10 is assumed.

3.2.2 Simulation Results

The simulation results of this model with these (assumed) parameters from 2006 to 2050 are displayed in Figure 5 on page 9. The number of local families / social apartments decreases as expected[8]. At the root of their respective outflows lie the perceived qualities of life, which are –in turn– partly determined by the average qualities of the apartments. No surprises so far. . .

3.3 Different Agent Profiles in a Single Model

Five simulation runs, all simulated with exactly the same model as already discussed in previous subsection, will be introduced in this subsection:

- the AgnetaOnlyA1 run which represents the situation in which all local and non-local families have an *individualist* profile,
- the AgnetaOnlyB1 run which represents the situation in which all local and non-local families have an *egalitarian* profile,
- the AgnetaOnlyA2 run which represents the situation in which all local and non-local families have a *fatalist* profile,
- the AgnetaOnlyB2 run which represents the situation in which all local and non-local families have a *hierarchist* profile,
- the AgnetaAverage run which represents the situation in which all local and non-local families have an average profile as already simulated and discussed in the previous subsection. This profile equals the assumed fractions of these profiles in the local population times the assumed values for each of these profiles (see table 6 on page 11).

3.3.1 The System Dynamics Model

The same model has been used as in subsection 3.2, but now simulated separately for these different groups of agents.

[8]While the number of non-local families / privately owned apartments increases, since they sum to 240 apartments.

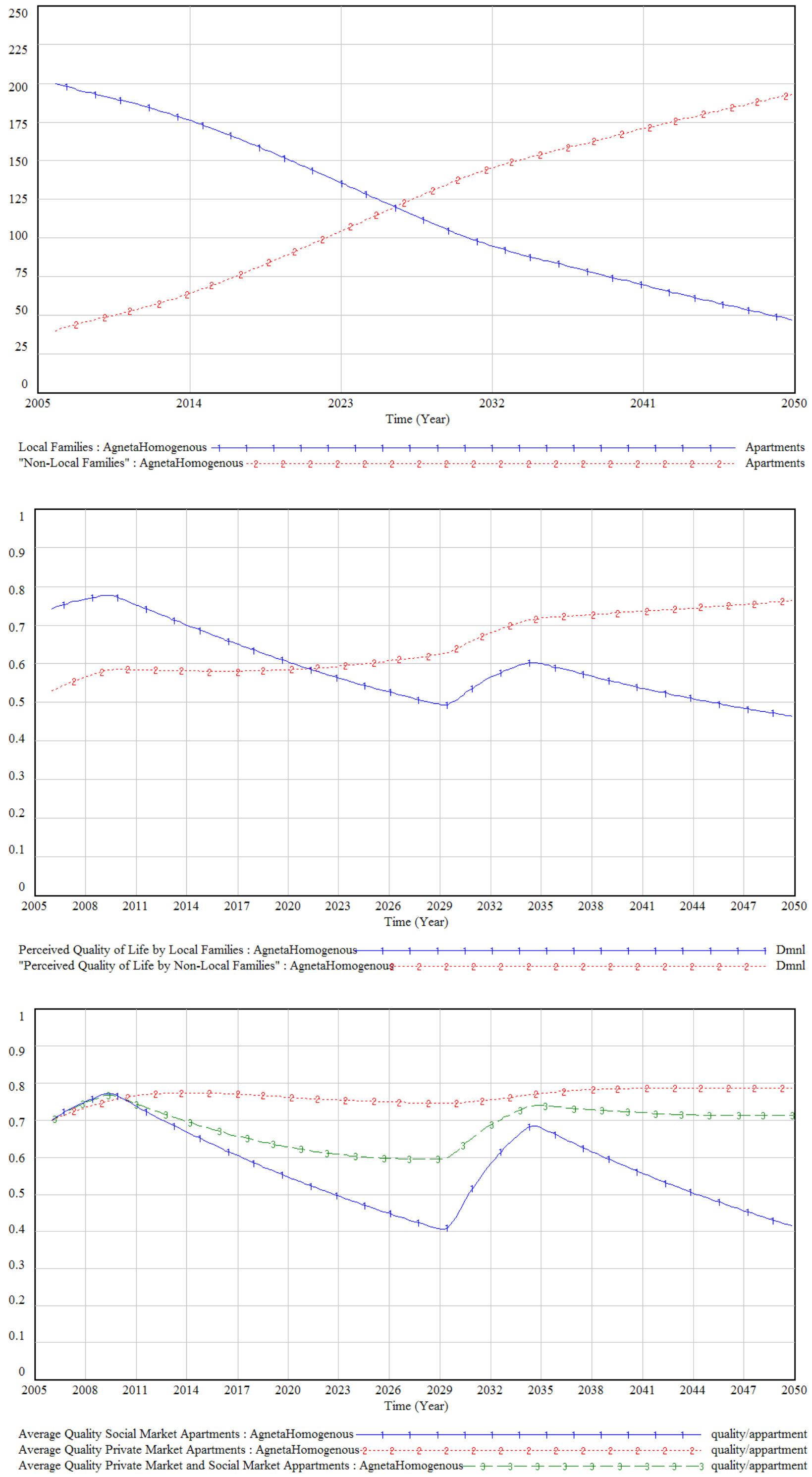


Figure 5: Agnetapark without profiles: Homogenous agents in a single model

	Individua-list (A1)	Egalita-rian (B1)	Fatalist (A2)	Hierarch-ist (B2)	Mean
Importance Social Cohesion for Local Families	0.1	0.2	0.45	0.40	0.32
" Quality of Neighbourhood for Local Families	0.1	0.7	0.10	0.40	0.40
" Quality of Own Apartment for Local Families	0.8	0.1	0.45	0.20	0.28
Stickiness Local Families	1	2	10	5	4.70
Importance Social Dominance for Non-Local Families	0.1	0.2	0.45	0.40	0.32
" Quality of Neighbourhood Non-Local Families	0.1	0.7	0.10	0.40	0.40
" Quality of Own Apartment Non-Local Families	0.8	0.1	0.45	0.20	0.28
Stickiness Non-Local Families	1	2	**2**	5	3.10
Fraction Profiles (in case of heterogenous agents)	0.1	0.3	0.2	0.4	

Table 1: Data used for the homogenous and heterogenous agents

3.3.2 Simulation Results

Figure 6a on page 11 gives an indication of the speed with which homogenous local families –that is, if they all belonged to the same profile– would leave the district, which is, inversely proportional to their perceived quality of life (Figure 6b) and their stickiness. One could conclude, at most, that the likely time required for all local families to leave the district will lie between the time required by a similar district with only A1 type of families and only A2 type of families.

The *Perceived Quality of Life of Non-Local Families* (Figure 6c) indicates that individualists and egalitarians might be most attracted to this district (not taking into account their space requirements and so on). However, the inflow of these different profiles cannot be assessed with these homogenous profiles. The average profile –or the B2 profile which is very close to the average profile– is probably most interesting to focus on if profiles are not explicitly modelled.

This is in fact a general remark: families in this (or any other) district are *not* homogenous, and some degree of heterogeneity of the agents is necessary to reach conclusions as to the likely evolution of the entire district.

3.4 Several Profiles as Agents in the Same Model

Now, several profiles are finally used to represent different groups of similar agents in the same model, dealing again with a district redevelopment case, similar to the redevelopment of the Agnetapark.

3.4.1 The System Dynamics Model

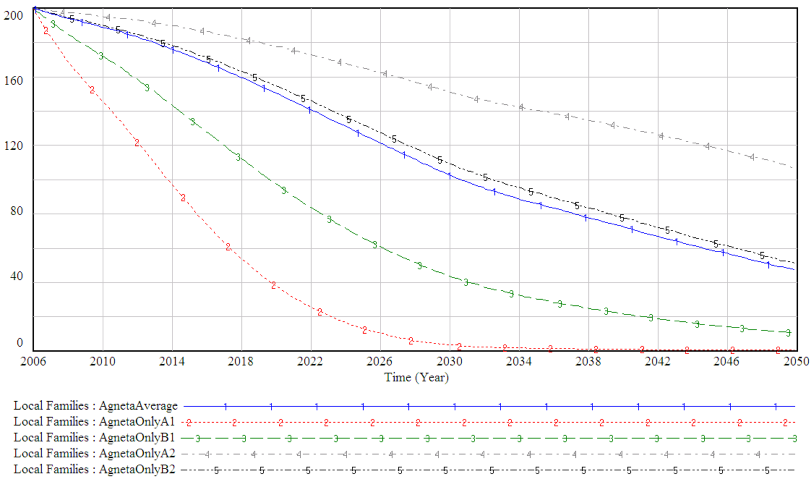
Almost the same model as in subsection 3.2 is used. The current model differs from the previous one on two aspects:

- it is subscripted[9] to create 4 different profiles (different groups of similar agents). The data assumed and used here, is displayed in table 1. The table also shows that the average profile used in previous subsections is in fact the sum of these profiles weighted by their respective fractions.
- the *Inflow of Non-Local Families* per lifestyle is made dependent on the relative *Perceived Quality of Life by Non-Local Families* of the different *lifestyles*.

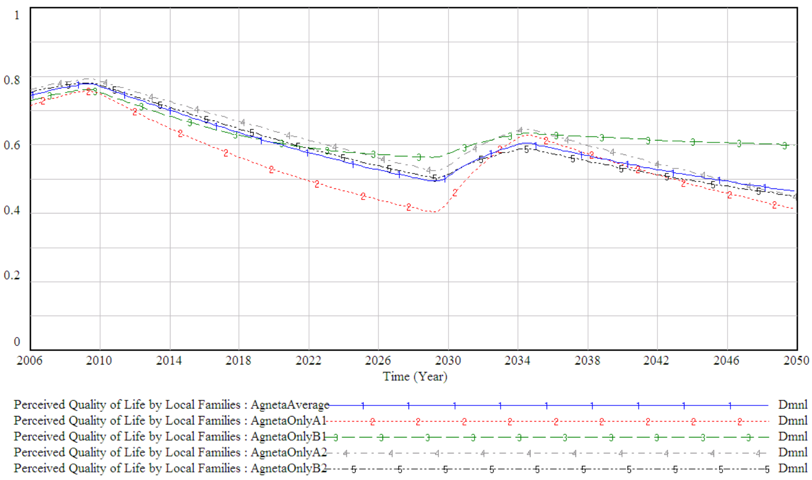
3.4.2 Simulation Results

Figure 7 on page 13 shows the simulated evolution of the *Local Families* (a), *Outflow of Local Families* (b), *Non-Local Families* (c), *Outflow of Non-Local Families* (d) for the four heterogenous groups of agents (profiles modelled by means of subscripts) in the same model. These outcomes are difficult to compare to the previous outcomes, since the total number of families per lifestyle

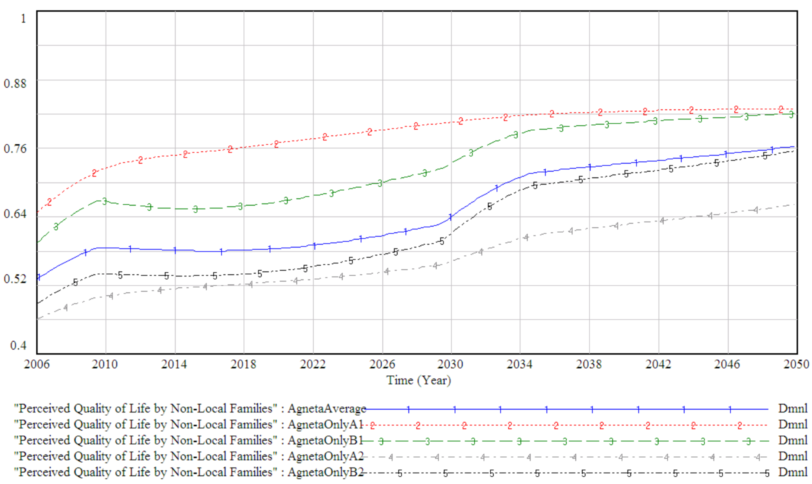
[9]This means that subscripts, a.k.a. arrays or vectors, are added to the model.



(a) Local Families



(b) Perceived Quality of Life Local Families



(c) Perceived Quality of Life Non-Local Families

Figure 6: Agnetapark with homogenous agents (profiles) applied separately to the same model: 1 = average profile ; 2 = A1 (individualists) ; 3 = B1 (egalitarians) ; 4 = A2 (fatalists) ; 5 = B2 (hierarchists)

differs from that of the previous simulation model with homogenous agents. The advantage of the current simulation model is that the subgroups and their evolutions can also be focussed on.

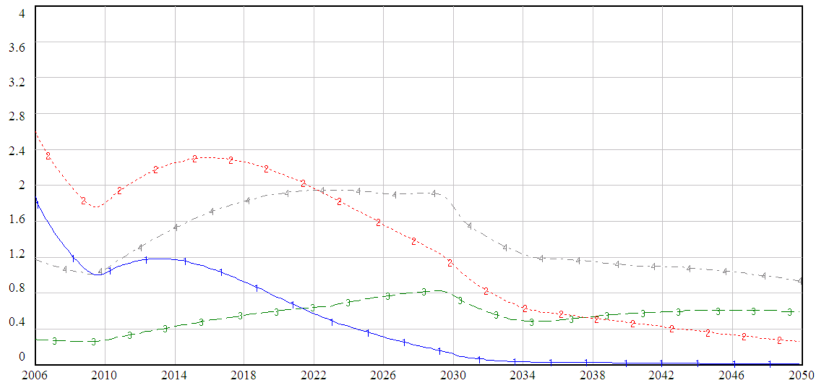
Figure 8 on page 14 displays the simulated evolution of the *Inflow of Non-Local Families* (a), the resulting total *Fractions of Lifestyles* in the district (b), the *Perceived Quality of Life by Local Families* (c), and the *Perceived Quality of Life by Non-Local Families* (d) for the four heterogenous groups of homogenous agents or profiles. It is interesting to see that the total fractions of lifestyles –in spite of the differentiated outflows– remains more or less the same for 'individualist families' (profile A1) and 'hierarchist families' (profile B2). For 'individualist families', who rotate very rapidly (low rotation time), this has to do with the high inflow of new families, caused by the highly attractive nature of the private apartments. For 'hierarchist families', who have a lower inflow, this has to do with their very high rotation time, which actually means that they rotate very slowly[10]. The fraction of 'egalitarian families' (profile B1) decreases because of a combination of a low rotation time and less compensation by the inflow than in case of 'individualist families'. The fraction of 'fatalist families' (profile A2) slightly increases, because of stickiness of local 'fatalist families' and the continuously increasing perceived quality of life of non-local 'fatalist families'.

The rotation times of the heterogenous agents are displayed in Figures 9b and 9d on page 15. They are compared to the rotation times of the homogenously modelled agents (Figures 9a and 9c). The rotation times of local families are, on the one hand, rather similar for homogenous and heterogenous agents (Figures 9a and 9b), while the rotation time of non-local families (Figures 9c and 9d) are, on the other hand, markedly different.

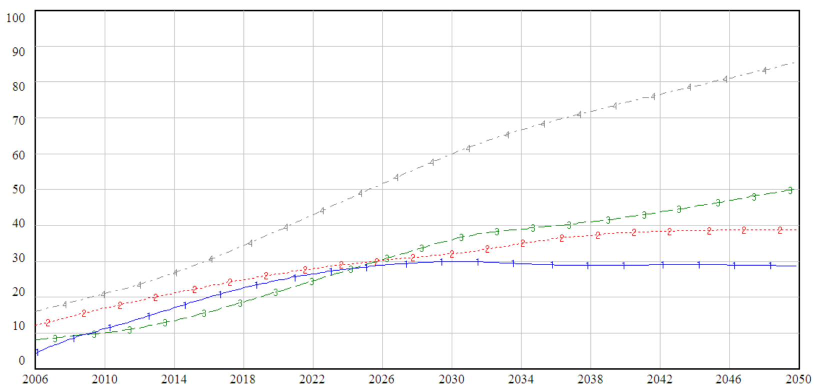
Hence, homogenously modelled agents cannot be used to capture the dynamics of the rotation time of non-local families. Profiles can. More importantly, homogenously modelled agents do not lead to insights related to the social mix, which might actually be important to some actors, and the dynamic consequences of the social mix. Until now, there are no dynamic consequences related to the social mix. These will be added in the next subsection.

[10]The rotation time equals the stock of families divided by the outflow.

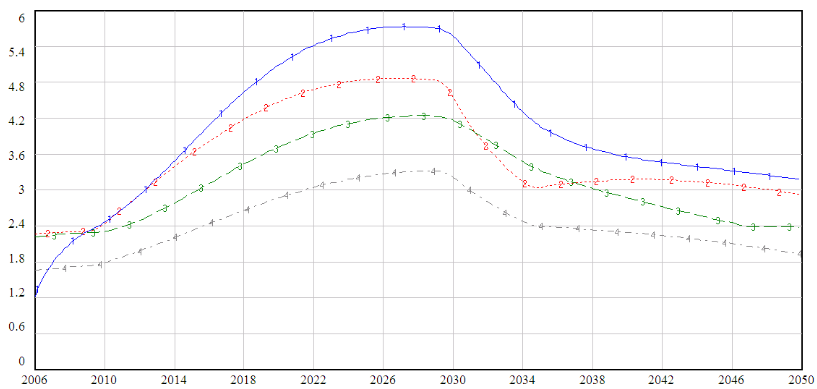
(a) Local Families



(b) Outflow of Local Families

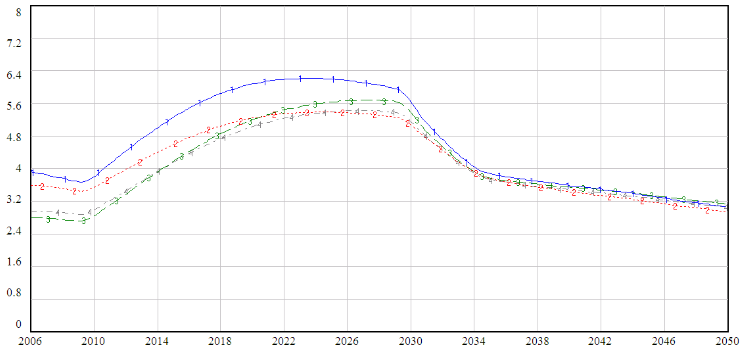


(c) Non-Local Families

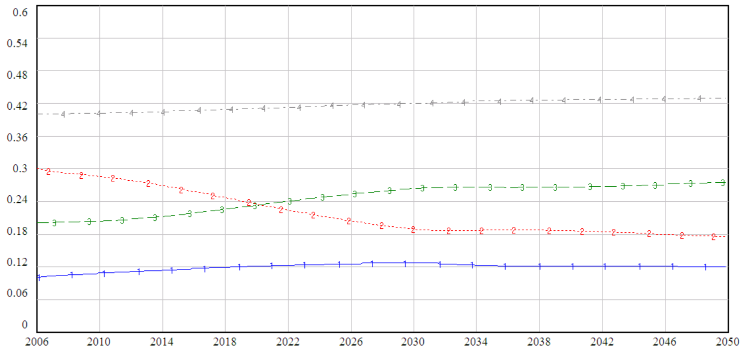


(d) Outflow of Non-Local Families

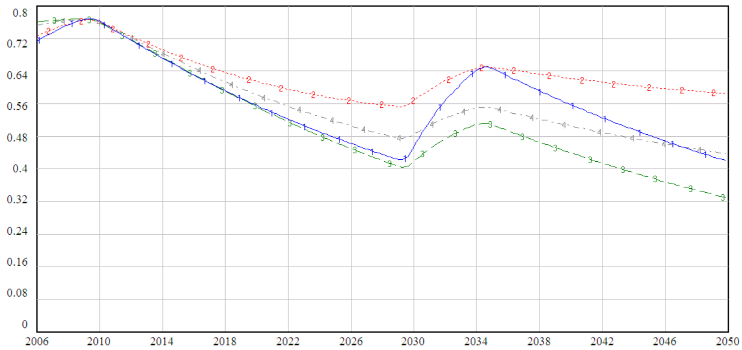
Figure 7: Agnetapark with heterogenous groups of agents (profiles) in a single model: 1 = A1 (individualists) ; 2 = B1 (egalitarians) ; 3 = A2 (fatalists) ; 4 = B2 (hierarchists)



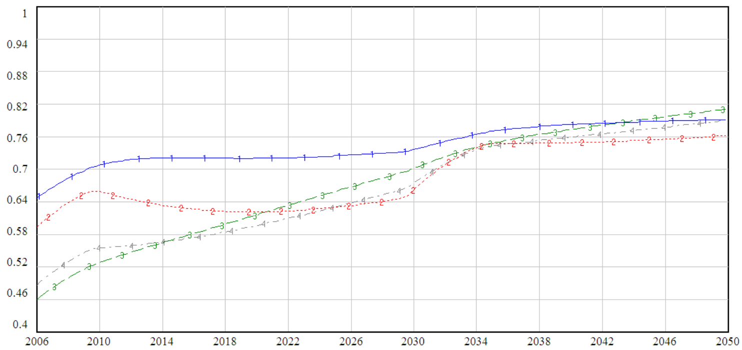
(a) Inflow Non-Local Families



(b) Fractions of Lifestyles of Families

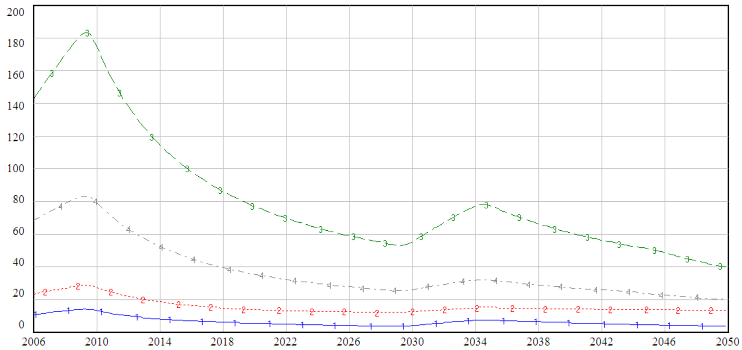


(c) Perceived Quality of Life by Local Families

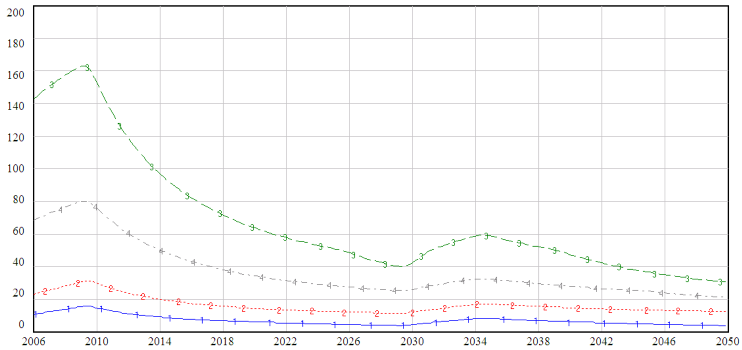


(d) Perceived Quality of Life by Non-Local Families

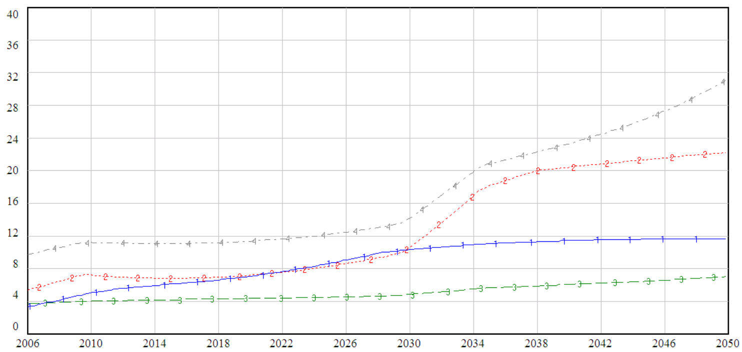
Figure 8: Agnetapark with heterogenous groups of agents (profiles) in a single model: 1 = A1 (individualists) ; 2 = B1 (egalitarians) ; 3 = A2 (fatalists) ; 4 = B2 (hierarchists)



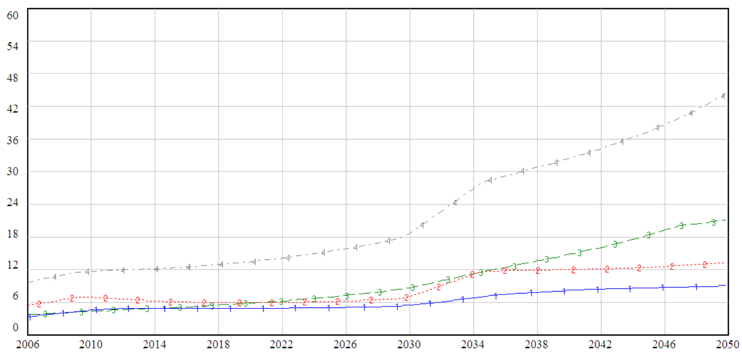
(a) Rotation Time Local Families for Homogenous Agents



(b) Rotation Time Local Families for Heterogenous Agents



(c) Rotation Time Non-Local Families for Homogenous Agents



(d) Rotation Time Non-Local Families for Heterogenous Agents

Figure 9: Comparison of rotation times of homogenous and heterogenous agents in a single model (1=A1; 2=B1 ; 3=A2 ; 4=B2)

3.5 Different Models for Different Profiles

These different profiles used here are –as discussed in subsection 2.3– linked to different world views. Different world views might actually lead to very different views on reality, and hence to the construction of different models of reality, different simulation results, different preferences, and different recommendations and decisions.

The TIME/TARGETS modelling studies (see among else (Rotmans and de Vries 1997; de Vries, Janssen, and Beusen 1999; van Asselt 2000)) have been among the first modelling studies in which profiles –also based on Cultural Theory– have been used to construct different simulation models about the same issue in order to illustrate the effect of different world views.

The model developed in the previous subsection will be slightly modified to illustrate the effect of different world views (A1, B1, A2, and B2) on models in combination with different profiles within these models.

3.5.1 The System Dynamics Models

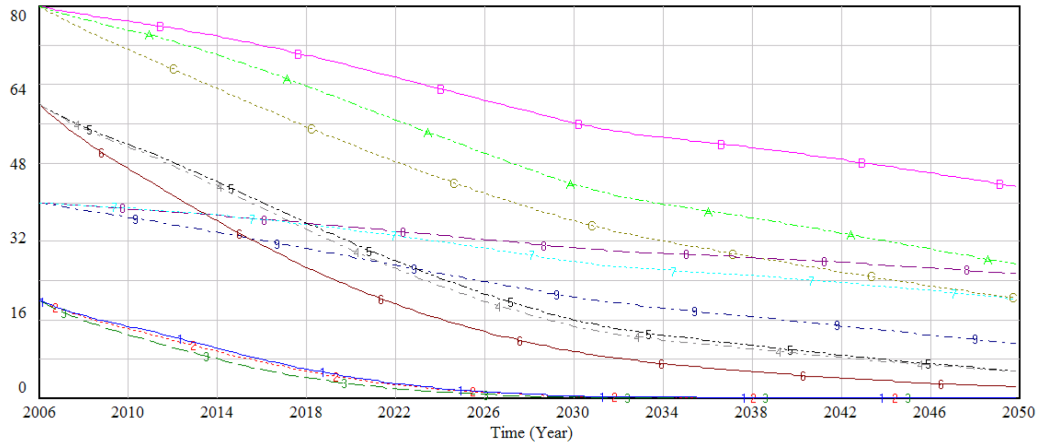
Four different models will be proposed here in order to reflect the four different world views. The models are just illustrative. They are only *slightly* different: they differ in terms of the variables *Social Cohesion Local Families* and the *Social Dominance Non-Local Families.* They could be seen as projections of the respective world views represented by a profile to the other profiles. It is assumed here that:

- Those with an A1-view do not care at all about social cohesion and social dominance. Projecting their own world view on the other groups, they expect that the other profiles do not care about social cohesion and social dominance either. The *Importance Social Cohesion for Local Families* and *Importance Social Dominance for Non-Local Families* are therefore in this first variant of the model (called viewA1) set to zero for all groups.
- Those with a B1-view prefer to live in a district in which the fraction of families with the opposite profile (A1 and B2 are opposites, as are A2 and B1) is as low as possible. Projecting their own preferences on the other profiles, they expect that families with other profiles prefer to live in a district with as low a fraction of families adhering to the opposite world view (A1 ↔ B2; A2 ↔ B1) too.
- Those local families with an A2-view prefer to live in a district in which the fraction of local families is as high as possible, and non-local families with an A2-view prefer to live in a district in which the fraction of non-local families is as high as possible. Projecting their own preferences on the other profiles, they expect that families with other profiles prefer to live in a district with as high a fraction of locals if they are locals themselves, and non-locals if they are non-locals. The resulting model is exactly the same as the model discussed in subsection 3.4.
- Those local families with a B2-view prefer to live in a district in which the fraction of their 'own kind' is as high as possible. Projecting their own preferences on the other profiles, they expect that families with other profiles prefer to live in a district with as high a fraction of families of their own profile too.

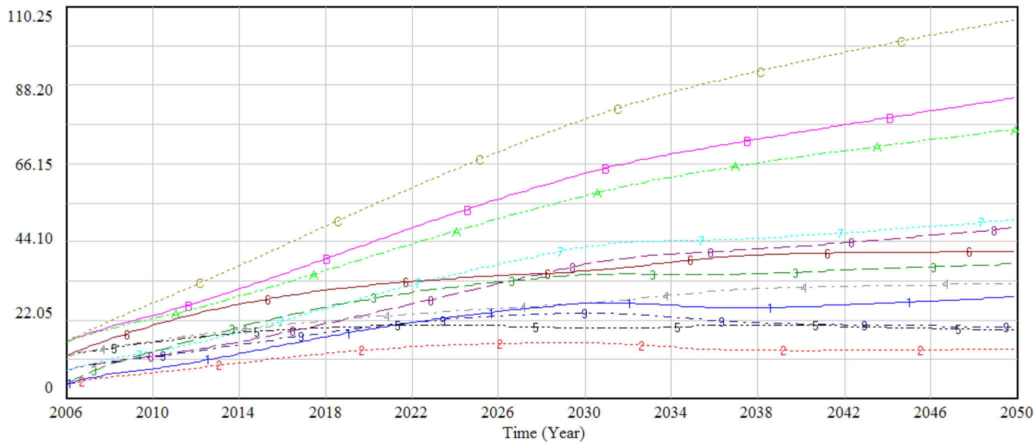
3.5.2 Simulation Results

Figure 10 shows the resulting behaviour of the *Local Families*, the *Non-Local Families*, and *Fractions of Families per Lifestyle* for three of the four models: the model corresponding to the (assumed) B2-view is not shown in the graphs, since it has already been shown in detail in subsection 3.4.

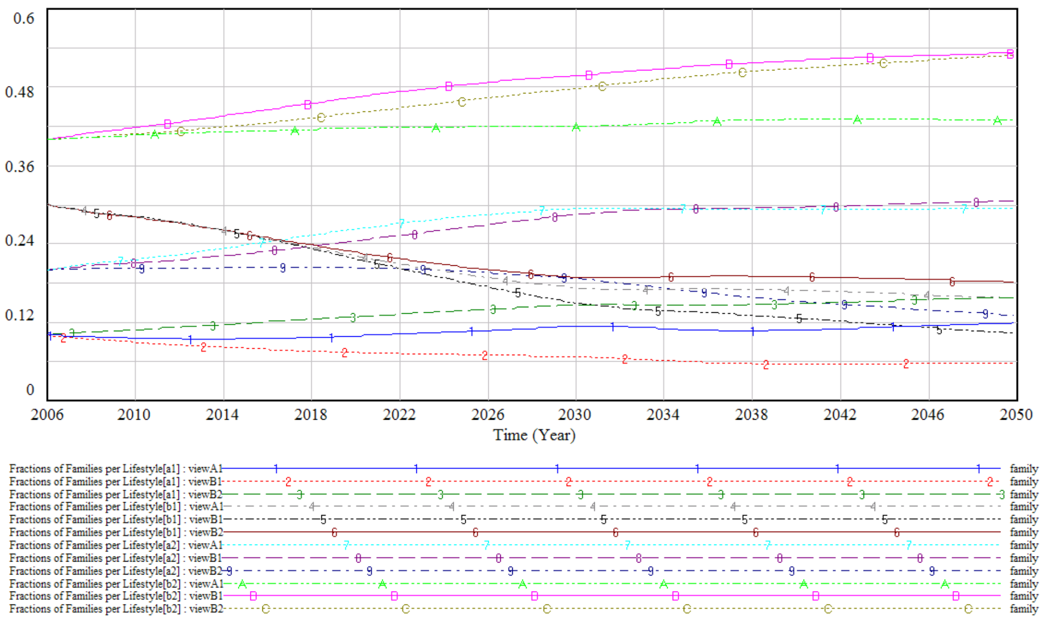
These small structural changes have a rather marked impact in terms of the number of *Local Families*, the number of *Non-Local Families*, and in terms of the *Fractions of Families per Lifestyle* (and even in terms of their modes of behaviour) as can be seen in Figure 10. Families with an A2



(a) *Local Families* for the A1, B1 and B2 views (the A2 view ∼ simulations in subsection 3.4)



(b) *Non-Local Families* for the A1, B1 and B2 views (the A2 view ∼ simulations in subsec.3.4)



(c) *Fractions of Families per Lifestyle* for the A1, B1 and B2 views (A2 ∼ simulations in subsec.3.4)

Figure 10: Agnetapark with heterogenous models *and* heterogenous agents

profile seem for example to be doing much worse in the B2-view model where families prefer to live in a district with families of their own kind.

4 Some Concluding Remarks

- The degree of agent heterogeneity of many System Dynamics models, focussed more on the system than on the agents, is, on the one hand, often too low or even non-existing. The degree of agent heterogeneity of many Multi-Agent models, focussed more on the agents than on the system, is, on the other hand, often too high. Finding the right balance between actor and system representation, and related to that the degree of actor heterogeneity, is important in many Multi-Actor Systems. Using profiles to represent heterogenous groups of homogenous agents in aggregated system models, might in many cases lead to a useful degree of agent heterogeneity, while keeping the system representation on a sufficiently aggregated level.

- The use of profiles in System Dynamics Modelling is especially relevant for Multi-Actor Systems in which the differences between different/incompatible world views, value systems, lifestyles, interests, or perspectives on the same system or issue matter, and in which the actors could be categorised by a reasonably small set of different agent profiles.

- Profiles could be used in System Dynamics Modelling to consider, analyse, model, investigate, illustrate, and communicate the implications of specific world views, to take value diversity into account, to construct new policies, to test for policy robustness and stakeholder support. Hence, using profiles could support –but should not replace– democratic and participate processes.

- Some advantages of the use of profiles in System Dynamics studies are that it might help to: frame analyses and structure problems, learn about/from other perspectives, recognise and deal with uncertainty, anticipate side effects related to actor perspectives/responses, and find overlooked options.

- Using profiles in System Dynamics modelling –within the models, to guide the construction of different models, or to evaluate the simulation results– and hence including different perspectives, might lead to more ethical and better policy recommendations, because of the fact that different world-views have been integrated and anticipated.

- The different versions of the System Dynamics model discussed in this paper have been kept as simple and small as possible, since the main purpose of this paper is to illustrate the use of profiles in System Dynamics models.

  The subscripted model can nevertheless be easily extended –with additional subscripts– to simulate the dynamics of different districts in the same city or region, of different profiles of inhabitants, of different family types, life stages and/or different income classes, of different types of houses and apartments, et cetera.

  The profiles could also be elaborated (more profiles[11] and/or more detailed profiles). Different structures could be added. And different policies might be simulated and their outcomes be evaluated for different groups of stakeholders or profiles.

  That way, the models developed here could be extended to help in real-world district redevelopment cases.

[11] Information about the lifestyle-types of the inhabitants of all districts in the Netherlands is available on the internet ('buurtinformatie' of WDM Nederland BV). This information has not been used here, since the number of different lifestyle-types of that typology is too high for the illustrative purpose of the paper (namely 20 different profiles).

Acknowledgments

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