The Soft Drugs Debate in The Netherlands: A Qualitative System Dynamics Analysis

August 12, 2009

Abstract

The Dutch Soft Drugs policy is currently under attack from all sides. Based on the opinions regarding the future Dutch soft drugs policy, the Dutch population and political arena could be divided into different groups: those in favour of full legalization, those in favour of more (but different types of) regulation, and those in favour of a full ban. The paper focusses on the points of view of those in favour of more regulation, since a full legalization or a full ban on soft drugs are unrealistic in the Dutch context. However, the group in favour of more regulation is also strongly divided into those in favour of more restrictive policies (compared to current policies) and those in favour of more tolerant policies (compared to current policies). The points of view of these two groups are analyzed in this paper using a qualitative System Dynamics perspective.

1 Introduction

1.1 The Dutch Policy of Tolerance

In November 2008, a 'Soft Drugs Summit' ('*Wiet Top*') was held in the Netherlands to discuss the future of the Dutch policy of tolerance related to soft drugs[1], known as 'het Nederlandse gedoogbeleid'. This policy of tolerance dates back to the 1970s (1971 and 1976). At that time, the Dutch government wanted to contact guard soft drugs users from getting into contact with hard drugs supply by separating soft drugs sales from hard drugs sales. Hence, it was argued at the time, soft drugs had to be decriminalized. Soft drug use is therefore legal and possession for own use is tolerated. After some time, new policies should have been proposed and accepted regarding the supply of the –currently approximately 700– 'coffee shops' (soft drugs bars), but only relatively minor changes were (1995). Hence, all soft drugs related activities are in fact illegal, especially the organized cultivation and trade, often called the 'back door' of the coffeeshop. However, the 'front door' of coffeeshops is tolerated if they do not cause any nuisance, do not sell hard drugs, keep less than 500g weed in store, and do not sell more than 5g weed per person per day. This situation survived later changes of policy: until today coffeeshops have been allowed to sell soft drugs for own use but are barred from transporting the drugs to their stores... That is the core of the Dutch policy of tolerance, often confused with a fully legalized soft drugs policy.

1.2 Unproblematic Aspects versus Problematic Aspects of Soft Drugs

On the one hand do recent finding show that some aspects of soft drugs are unproblematic:

- soft drugs are (generally speaking) moderately physically harmful and moderately lead to dependence (at least less than alcohol or tobacco on both criteria)
- the Dutch separation of distribution of soft and hard drugs is successful

[1] The phrase 'soft drugs' refers in this text most of all to the cannabis products, psychoactive drug from cannabis plant (THC), often referred to as cannabis, marijuana, weed ('wiet' in Dutch), grass, hemp, or hashish.

- soft drugs are (among else because of the previous point) not to be considered gateway drugs
- frequent use is an indicator for multi-problems situations
- and soft drugs are, generally speaking, not a societal problem.

On the other hand do recent finding show that some aspects of soft drugs are problematic:

- soft drugs are very harmful to youngsters (-25), especially in combination with alcohol and tobacco
- the ever higher concentration of THC blurs the line between hard and soft drugs and could lead to (earlier) manifestations of psychotic disorders
- for some towns at Dutch borders, drugs tourism causes serious troubles, both locally and internationally
- and, last but not least, the professionalization/criminalization of organised crime involved in cultivation/trade of soft *and* hard drug, on an international level beyond the coffeeshops.

These insights differ a lot from those at the basis of the Dutch Policy of Tolerance stemming from 1971/1976.

1.3 The End of the Policy of Tolerance?

At the time of the 'Wiet Top', it already looked as though almost everybody in The Netherlands recognized the same problems and agreed that the policy of tolerance needed to be revised. Dutch citizens (and Dutch political parties) are nevertheless strongly divided about the policy that – according to their point of view– ought to replace the current policy of tolerance related to soft drugs. Hence, very different directions of the revision were proposed, from prohibition/banning, over different modes of regulation, to full legalization.

After the 'Wiet Top' in November 2008, the Dutch government erected a Drugs Policy Commission ('Adviescommissie Drugsbeleid'), in February 2009, to analyse current conditions/insights, and to recommend policy based upon them. According to the Drugs Policy Commission, its goal was to develop an integrative, balanced, and dynamic approach to prevent and reduce drug use inasmuch it is harmful (health and social), and to prevent and reduce harm caused by drug trade. In order to analyse current conditions/insights, the Drugs Policy Commission extensively used other reports like the 'Risicoschatting cannabis 2008' ('Risk Assessment Cannabis 2008') report (CAM 2008) and 'De ranking van drugs' ('Ranking of Drugs') report (RIVM/AIAR 2009). In July 2009, the Drugs Policy Commission presented its report 'Geen deuren maar daden' ('No Doors But Deeds') (van de Donk, Boekhoud, van den Brink, et al. 2009). The main finding of the Drugs Policy Commission report is that changed conditions/insights demand adaptations to the policy of tolerance without fundamentally changing it.

The commission dismisses both a full legalization and full prohibition given the Dutch context. It analyses four cases of coffeeshop regulation (see Figure 1):

- II: *open access/one-sided regulation* which corresponds to the current situation (to be changed) in which the front door of the coffeeshop is open to anyone and the back door is not regulated.
- III: *open access/two-sided regulation*, in which the the back door of the coffeshop becomes more regulated (regulated cultivation and trade) and the front door remains open.
- IV: *restricted access/one-sided regulation*, which is recommended by the commission, in which the front door of the coffeeshop becomes more strictly regulated (e.g. membership-only) and the back door remains unregulated.
- V: *restricted access/two-sided regulation* in which both the front door of the coffeeshop (e.g. membership-only) and the backdoor become more regulated.

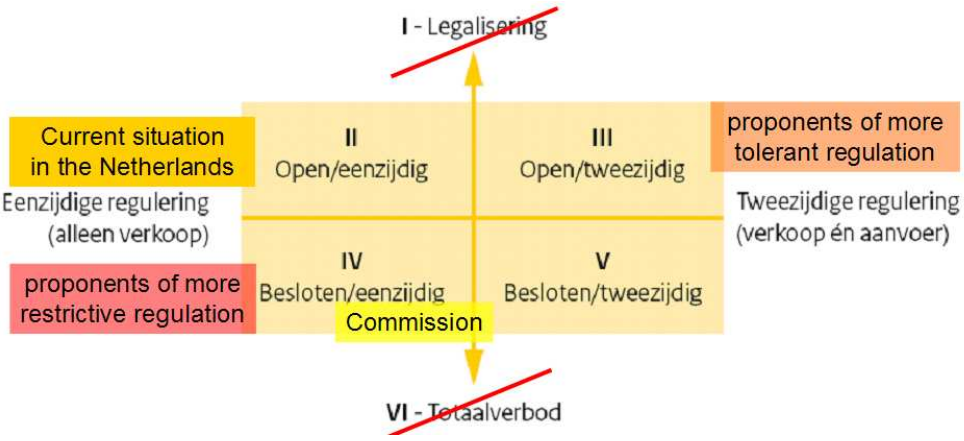

Figure 1: Positions in the Dutch soft drugs debate. Adapted from (Commissie Drugsbeleid, 2009)

Figure 1 also shows the groups whose opinions and policies are modelled in this paper:

- The first group consists of proponents of a more tolerant soft drugs policy, with regulated cultivation and supply of coffee shops. They argue that a soft drugs ban is counterproductive because illegalization leads to soft drugs cultivation/sales/use going underground. Most Dutch proponents of a more tolerant soft drugs policy are nevertheless of the opinion that coffee shops causing trouble ought to be closed[2]. This position corresponds more or less to the *open access/two-sided regulation* (III).
- The second group consists of proponents of a more restrictive soft drugs policy, banning soft drugs, of closing of coffee shops instead of regulating their supply, and of the adoption of more severe punishments for soft drugs cultivation, trade and use. This position corresponds more or less to the *restricted access/one-sided regulation* (IV) recommended by the commission.

These two opposing points of view correspond to the major points of view found in Dutch society: even the majority parties and the opposition are evenly spread out over these points of view. In September 2009, the Dutch Cabinet will most likely start this revision process, which promises –given the divides– to become an extremely interesting policy analysis case.

1.4 Organization of the Paper

In this paper, the two opposed directions of the revision outlined above will be analyzed from the perspectives of those in favor of a more tolerant soft drugs regulation and those in favor of more restrictive soft drugs regulation, by means of qualitative System Dynamics, more precisely, causal loop diagrams. Section 2 briefly introduces the domain of qualitative System Dynamics. Section 3 deals with a more tolerant policy from the perspective of the proponents of a more tolerant policy. Section 4 deals with a policy of a less tolerant policy from the perspective of the proponents of a more tolerant policy. Section 5 deals with a policy of a more restrictive policy from the perspective of the proponents of a more restrictive policy. Section 6 deals with a more tolerant policy from the perspective of the proponents of a more restrictive policy. An integrated analysis can be found in section 7. The use of a teaching/testing case based on this issue is briefly discussed in section 8. And concluding remarks and recommendations are distilled in section 9. The polemic between proponents of quantitative System Dynamics and proponents of qualitative System Dynamics is briefly discussed in appendix B. And appendix A contains the 'hot teaching/testing' case description.

[2]Since 1999 local Dutch politicians have the right to shut down coffee shops. Part of the decrease of the number of coffee shops –according to a study of the Utrecht Trimbos Institute from 1179 in 1997 to 737 in 2004– can be attributed to this right.

2 Methodology: Qualitative System Dynamics – Causal Loop Diagrams

System dynamics is a systems methodology used to represent (assumed) system structures of complex systems/issues, to derive the possible behavior(s) over time from the (assumed) underlying system structures, and to assess the appropriateness of structural policies to improve the perceived system behavior.

Traditionally, qualitative System Dynamics diagrams are mostly constructed to structure issues or conceptualize systems before turning them into quantitative System Dynamics simulation models, or to communicate the (feedback loop) structure of simulation models. Qualitative System Dynamics diagrams are sometimes also used in a stand-alone mode, without turning them into quantitative simulation models, in order to communicate mental models and/or (perceived feedback loop) structures, and sometimes to 'mentally' simulate possible behavior(s). Often used qualitative System Dynamics diagrams are Causal Loop Diagrams [CLDs]. They map the feedback loops made up of causal relationships between system elements. These causal models are in fact ensembles of causal assumptions (**?**). Following symbols are mostly used in causal loop diagrams:

- $\overset{\rightarrow}{+}$ represents a positive causal influence. It indicates that if the influencing variable increases (decreases), all things being equal, the influenced variable increases (decreases) too above (under) what would have been the case otherwise, or $A \overset{\rightarrow}{+} B \Rightarrow \frac{\partial B}{\partial A} > 0$.
- $\overset{\rightarrow}{-}$ represents a negative causal influence. It indicates that if the influencing variable increases (decreases), all things being equal, the influenced variable decreases (increases) under (above) what would have been the case otherwise, or $A \overset{\rightarrow}{-} B \Rightarrow \frac{\partial B}{\partial A} < 0$.
- $\overset{\not\rightarrow}{+}$ and $\overset{\not\rightarrow}{-}$ represent a positive and a negative causal influence with a delay.
- $\circlearrowleft$ and $\circlearrowright$ represent negative feedback loops. A feedback loop is called negative or balancing if an initial increase (decrease) in variable A leads after some time to a decrease (increase) in A. In isolation, a negative feedback loop leads to balancing or goal-seeking behavior.
- $\oplus\!\circlearrowleft$ and $\oplus\!\circlearrowright$ represent positive feedback loops. A feedback loop is called positive or reinforcing if an initial increase (decrease) in variable A leads after some time to an additional increase (decrease) in A. In isolation, a positive feedback loop leads to exponential growth or decay.

Extended Causal Loop Diagrams can often be turned into more simplified and aggregated (archetypical) diagrams, which are easier to simulate mentally.

Regarding the use of purely Qualitative System Dynamics , the System Dynamics community seems to be divided in proponents[3], opponents[4], and a majority of pragmatic system dynamicists who use (a combination of) both depending on the situation (for more on this divide, see appendix B).

3 A more tolerant soft drugs policy from the perspective of the proponents of a more tolerant soft drugs policy

The point of view of proponents of regulating soft drugs cultivation/trade/use will be summarized in this section by means of a causal loop diagram (see Figure 2). These causal loop diagrams were developed the day after the 'Wiet Top', mainly based on news paper articles and blogs. Following assumptions are explicitly included:

A policy of more *illegalizing and repression* leads to more *illegality of soft drugs cultivation, sales and use*, which, ceteris paribus, results in an increasing *soft drugs price*, more *street dealing*

[3] A group of practitioners believes that quantitative models could be dangerous in case of too many uncertainties and believe that isolated qualitative models are useful in their own respect.

[4] A group of practitioners favours quantitative models and numerical computer simulations at any time and reject isolated qualitative modeling.

and more *small criminality*. More *street dealing and small criminality* leads immediately to more *societal nuisance*.

An increasing *soft drugs price* leads to an increasing *profitability of illegal soft drugs business*, which results –after some time– in an increase of the *size of the illegal soft drugs business*. The latter increase leads to an increase in the (financial) *power of soft drugs criminals* [or 'business men'], which in turn results in an increase of *heavy criminality* [or at least black money].

Both an increase of *societal nuisance on the street* and an increase of *heavy criminality* leads to more *societal resistance against the illegal soft drug business*, which leads –if it were up to them– to a *stronger call for a more tolerant soft drugs policy*.

It is often assumed by proponents of a more tolerant soft drugs policy that an increasing *illegality of soft drugs business and use* lead to an increasing *attractiveness of occasional soft drugs use*, which leads to an increasing *soft drugs use*, and indirectly, both directly and indirectly (an increase of the *attractiveness of occasional soft drugs use* leads after some time to an increasing *addicted soft drugs use*). The *soft drugs use* drives the *soft drugs demand*. An increase of the *soft drugs demand* leads, ceteris paribus, to an increase of the *soft drugs price*.

An increase in the *size of the illegal soft drugs business* leads to an increase of *illegal soft drugs cultivation*, that in turn increases *total soft drugs supply*. An increase of the *total soft drugs supply* leads, ceteris paribus, to a decrease of the *soft drugs price*.

Calls for a more tolerant soft drugs policy should –from the point of view of proponents of a more tolerant soft drugs policy– lead to policies that decrease the *illegality and repression*, which means (more) *legal soft drugs cultivation*, and more *control over coffee shops* which means less *societal nuisance caused by coffee shops* (dotted lines).

An important explicit assumption in this line of reasoning is that illegality makes soft drugs use more attractive.

An important implicit assumption from the causal loop diagram in Figure 2 is that soft drugs use is price inelastic (an increase- or decrease of the soft drugs price does not direct lead to a decrease or increase of the soft drugs use). Another implicit assumption relates to the↻'`the higher the soft drugs price the more illegal cultivation`' loop: proponents of a more tolerant soft drugs policy seem to assume that –without full legalization– soft drugs prices and profitability of the illegal soft drugs business will never collapse. Finally, it is implicitly assumed in the causal loop diagram that there will be some sort of price regulation on the legal soft drugs market, but that the illegal soft drugs business will remain unregulated.

All these explicit and implicit assumptions are bundled in the extended causal loop diagram in Figure 2. If the link between *call for soft drugs policy* and *illegality and repression of the Dutch soft drugs policy*, and the *legal soft drugs cultivation* policy are included, then this causal loop diagram contains 7 negative feedback loops. The behavior of this system could already be derived (partially) from this diagram. However, the link between structure and behavior will be even more obvious after aggregation:
The↻'`legal business decriminalizes in small`',↻'`legal business decriminalizes in big`', and↻'`coffee shop control`' loops in Figure 2 can be taken together in the↻'`legal business decriminalizes`' loop in Figure 3. The↻'`illegality attracts`' loop and the↻'`occasional use can lead to addiction`' loop in Figure 2 can be taken together in the↻'`legality suppresses excitement`' loop in Figure 3.

The aggregated causal loop diagram is easier to use for mentally simulating possible system behaviors. This diagram contains 3 negative feedback loops influenced directly by the policy that are assumed to reduce the *illegal soft drugs price* –assumed to be market driven– and consequently the organised *soft drugs criminality*, and in case of a full legalisation even eliminate it. There is one negative feedback loop –the '`price-driven illegal cultivation`' loop– that somewhat thwarts the elimination of *illegal soft drugs cultivation*.

Even if the price of legal soft drugs would be market driven, then the↻'`price-driven illegal cultivation`' loop will not be activated if the decrease of the *illegal soft drugs cultivation* is more than compensated by an increase of the *legal soft drugs cultivation* such that the *soft drugs*

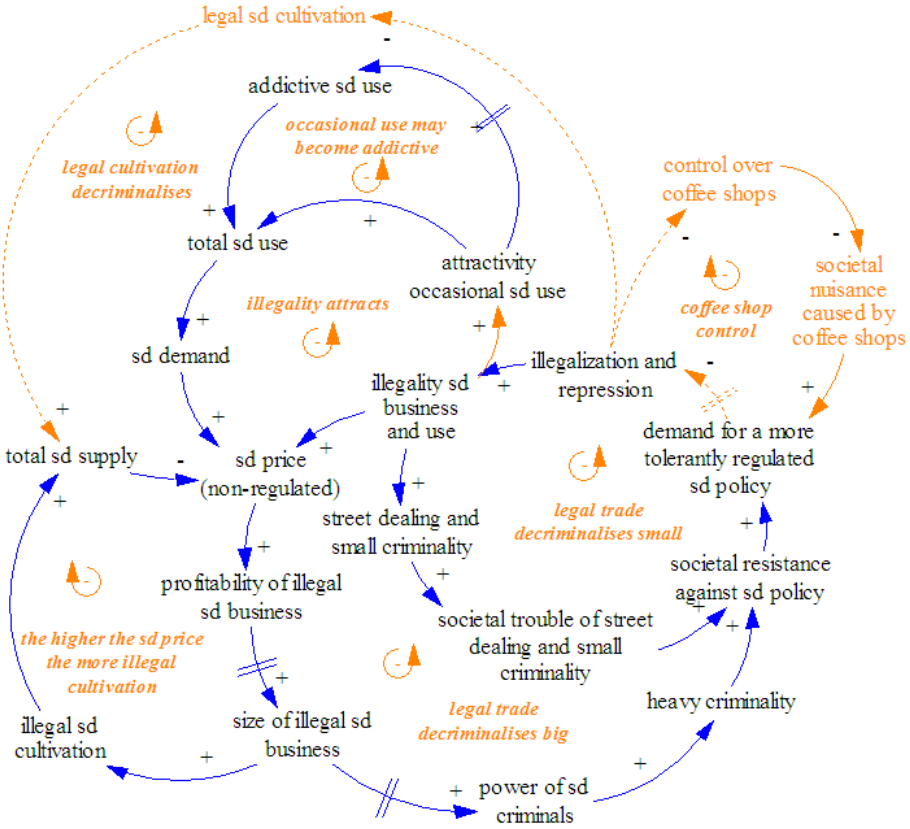

Figure 2: Causal loop diagram of a more tolerant soft drugs policy from the point of view of proponents of a more tolerant soft drugs policy. Assumptions specific for these proponents are displayed in orange. Dotted lines represent their policies and 'sd' stands for soft drugs.

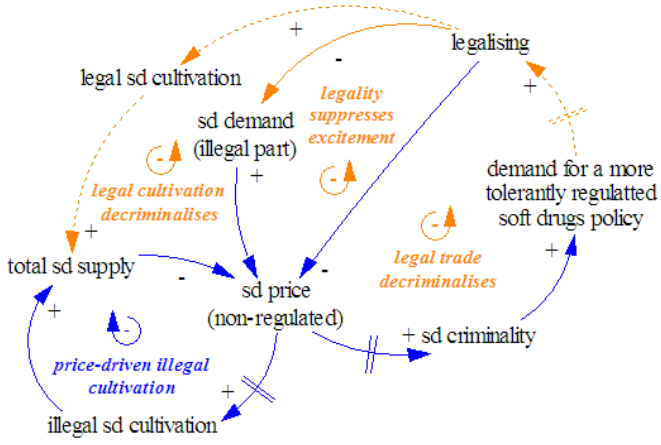

Figure 3: Aggregated CLD of a further legalization from the point of view of proponents of a legalizing. Assumptions specific for proponents of legalisation are displayed in orange. Dotted lines represent their policies.

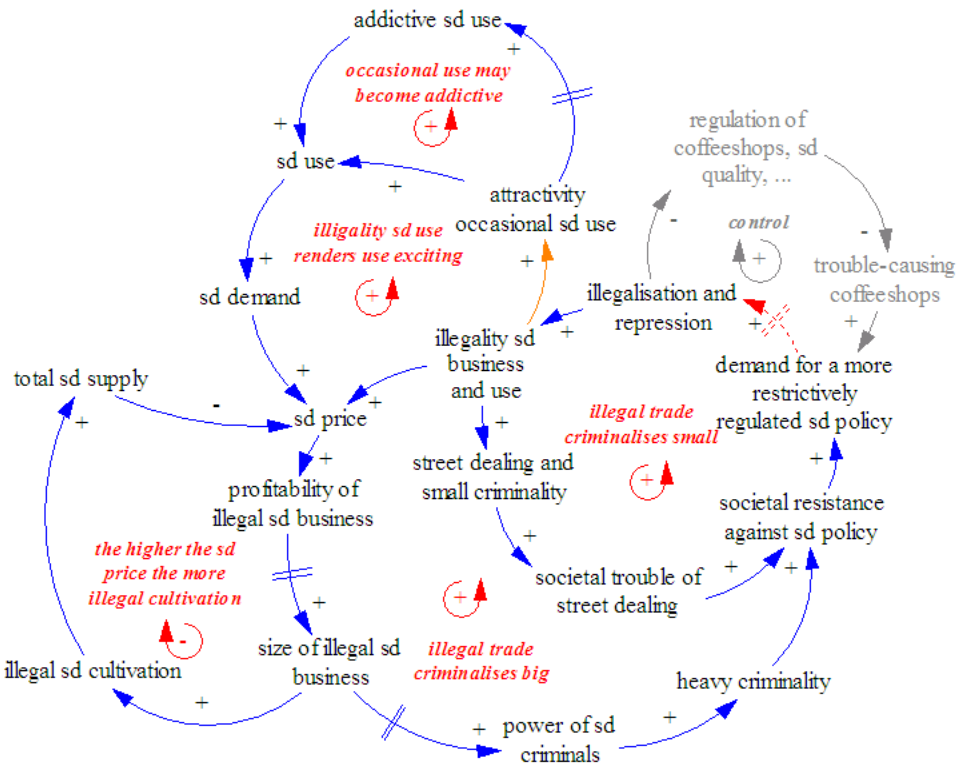

Figure 4: Causal loop diagram of the a further banning of soft drugs from the point of view of proponents of legalizing soft drugs

price does not significantly rise. In that case, legalizing may also lead to less soft drugs-related criminality and a lesser call for new soft drugs policies.

4 A more restrictive soft drugs policy from the perspective of the proponents of a more restrictive soft drugs policy

In this section, a more restrictive policy (towards banning soft drugs) is presented from the perspective of proponents of a more tolerant soft drugs policy, starting from the causal loop diagrams in Figures 2 and 3. The opponents of a more restrictive soft drugs policy are of the opinion that an increasing *demand for soft drugs policy* needs to be answered with policies that lead to more *illegalizing and repression* [note: this implies a change in polarity of the link between *demand for sd policy* and *illegalization and repression*], and that legal soft drugs cultivation is quite unacceptable [note: this means eliminating the ↻'`legal cultivation decriminalises`' loop]. These assumptions are incorporated in the causal loop diagrams in Figures 4 and 5 without changing the rest of the causal loop diagrams.

The change in link polarity leads to a change of most loop polarities (compare Figures 2 and 4). The latter diagram represents a more restrictive soft drugs policy (that is to say, more and more illegalization and repression) from the point of view of the proponents of a more tolerant soft drugs policy.

Then, almost all feedback loops become reinforcing loops, leading to escalating trouble and restrictiveness. Hence, more restrictive/banning policies do not make any sense for proponents of a more tolerant soft drugs policy (at least not in the causal loop diagram supposed to represent their world view).

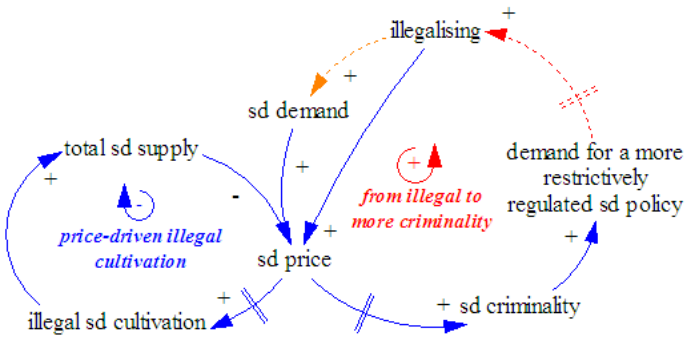

Figure 5: Aggregated causal loop diagram of a more restrictive soft drugs policy from the point of view of proponents of a more tolerant soft drugs policy

5 A more restrictive soft drugs policy from the perspective of the proponents of a more restrictive soft drugs policy

Proponents of a more restrictive soft drugs policy seem to have another world view than proponents of a more tolerant soft drugs policy. New causal loop diagrams will therefore be constructed. Major assumptions of proponents of a more restrictive soft drugs policy are that criminality and soft drugs can be controlled, that soft drugs use is price elastic, and that soft drugs supply is rather inelastic.

Explicit assumptions are represented by the causal loop diagram in Figures 6 and 7. These figures show that the demand for more soft drugs policy followed by more restrictive policies (illegalization, repression, more power to police and justice, and banning of coffee shops) lead –in the world view of those in favour of banning– to decreasing societal trouble and criminality, and to decreasing soft drugs demand and supply.

6 A more tolerant soft drugs policy from the perspective of the proponents of a more restrictive soft drugs policy

The explicit assumptions of the combination of a more tolerant soft drugs policy with the perspective of the proponents of more restrictive soft drugs policies are represented in Figures 8 and 9.

From the point of view of proponents of a more restrictive soft drugs policy, a revision of soft drugs policies in the direction of further legalization does not work. For them, further legalization criminalizes and escalates. Moreover, it also increases the supply, lowers the price and increases the use, met all related consequences.

7 Synthesis: combining more and less restrictive regulation

It should be clear from the previous sections that a policy from one world view does not make sense in the other world view. So, the two policies only seem to be satisfactory from their own point of view. Crucial assumptions differ among these points of view.

In this section, an integrative policy –taking elements from both policies– is tested from both points of view. A combination of both previously discussed policies may indeed offer a way out: combining legal cultivation of soft drugs, controlled legal sales for personal use in coffee shops, and a total ban on all other soft drugs related transactions may be appropriate from both points of views.

The proposed policy would consist of:

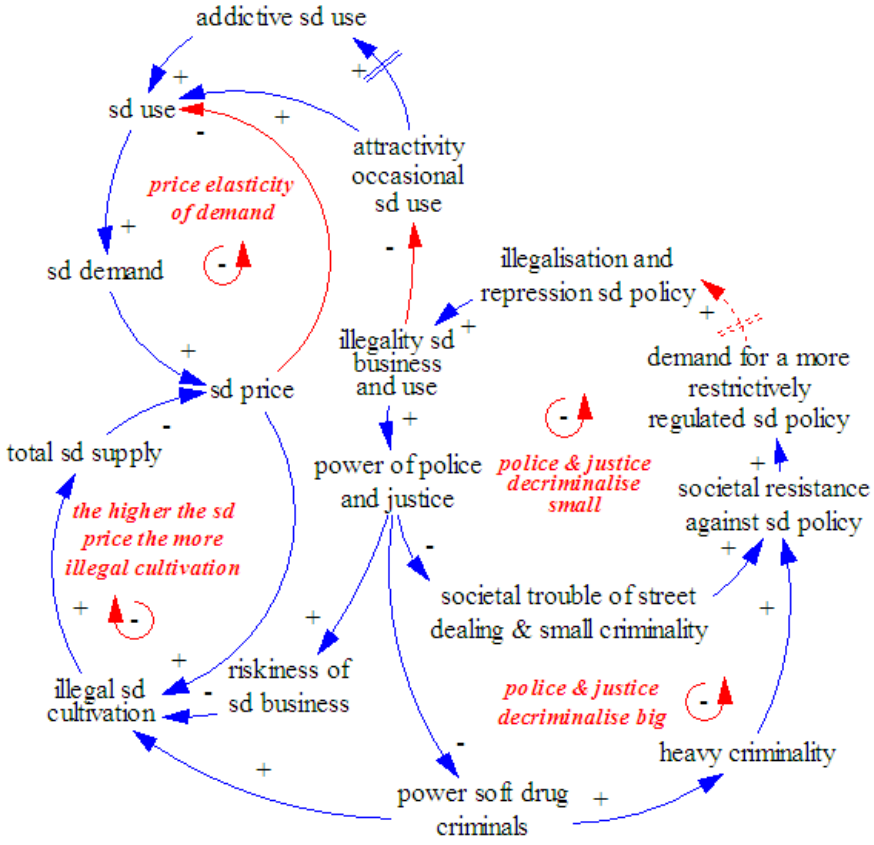

Figure 6: Causal loop diagram of a more restrictive soft drugs policy from the point of view of proponents of a more restrictive soft drugs policy

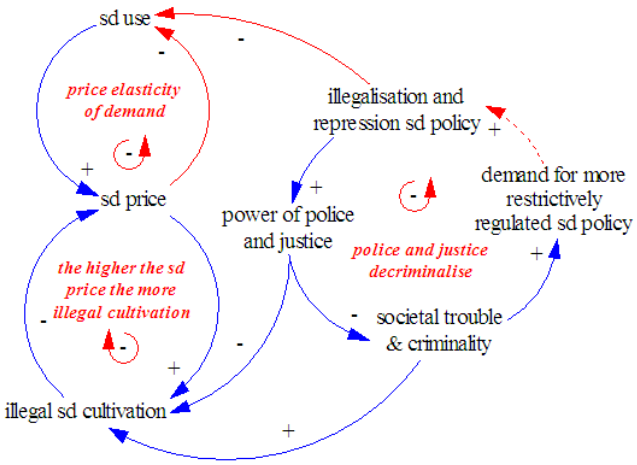

Figure 7: Aggregated causal loop diagram of the a more restrictive soft drugs policy from the point of view of proponents of a more restrictive soft drugs policy

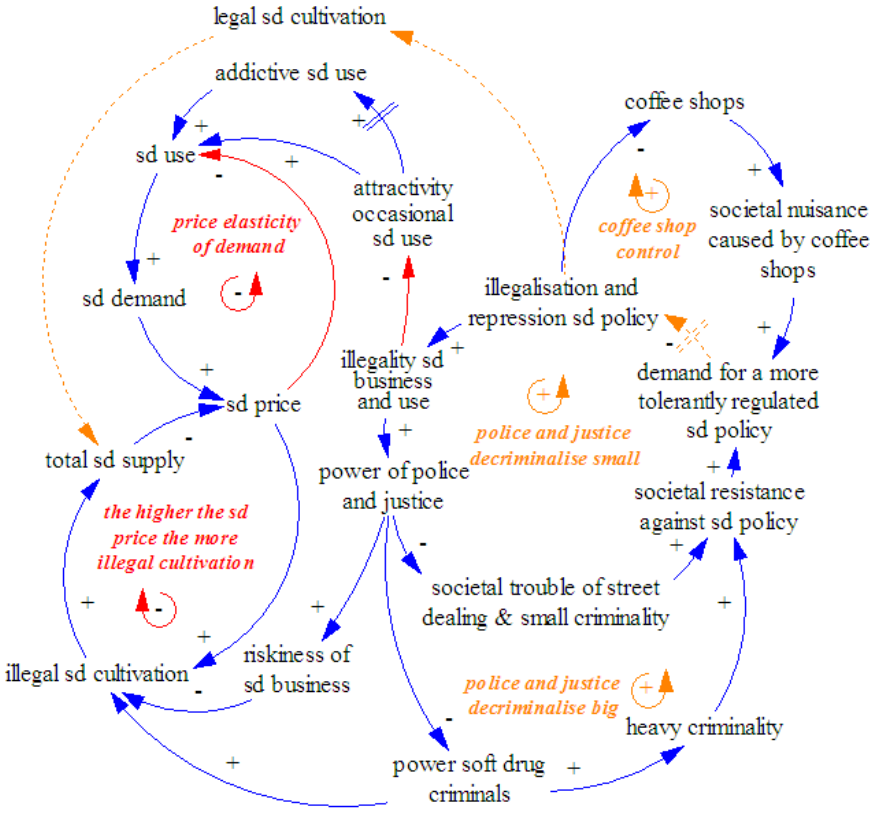

Figure 8: Causal loop diagram of the a more tolerant soft drugs policy from the point of view of proponents of a more restrictive soft drugs policy

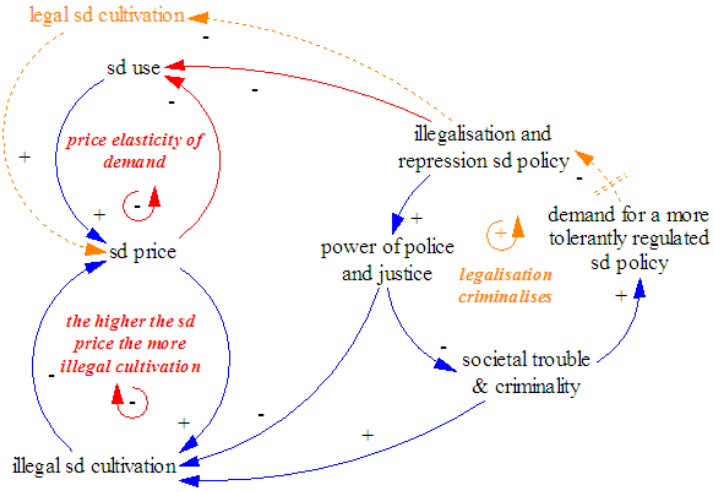

Figure 9: Aggregated causal loop diagram of a more tolerant soft drugs policy from the point of view of proponents of a more restrictive soft drugs policy

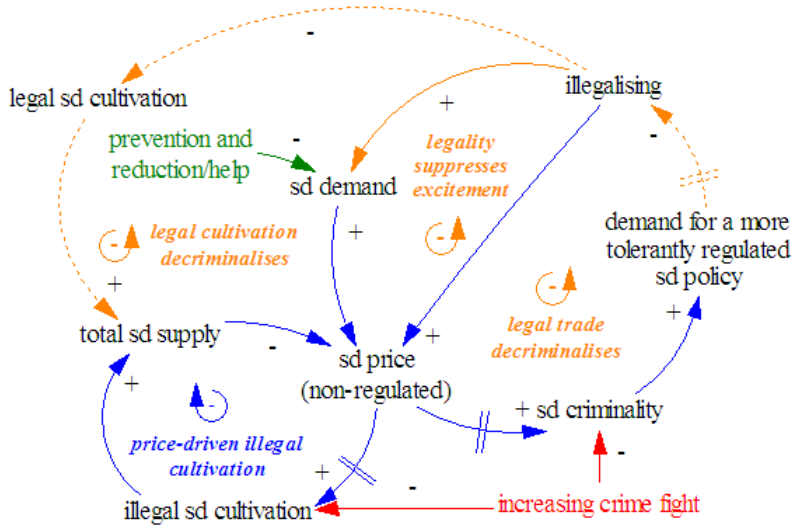

Figure 10: The synthesis policy from the aggregated point of view of proponents of more tolerant soft drugs policies

- Gradually increasing the regulated supply of soft drugs: from pilots to plantations while shutting down illegal ones at about the same rate
- Gradually increasing the fight against (big) crime
- Partly closed coffeeshops to reduce societal trouble:
  - Most local coffeeshops could function on a members-only basis.
  - Some well-situated coffeeshops (near the borders) may work on an open/ID-based on a use-in-the-shop-only basis.
- Supplemented of course with a multi-modal approach to prevention and reduction of individual harm and help in case of multi-problem situations.

As can be derived from the causal loop diagrams in Figures 10 and 11, this combined policy leads in both world views to less illegal cultivation, less criminal power and money, less societal nuisance, more control, and –if soft drugs prices do not decrease– less use.

8 The Corresponding 'Hot' Testing/Teaching Case

The models corresponding to the point view of the proponents of legalisation (as in sections 3 and 4) were actually developed as a 'hot' testing case for BSc students at the Faculty of Technology, Policy and Management of Delft University of Technology.

The use of 'hot' issues for testing/teaching is one of several recent innovations in the Introductory System Dynamics course at Delft University of Technology (see (Pruyt et al. 2009)). For a discussion of 'hot' testing/teaching case and more examples of 'hot' cases, see (Pruyt 2009b). Two other recent 'hot' teaching and testing cases are discussed in (Pruyt 2009a) and (Pruyt 2009c).

The test took place on 27 November 2008, 6 days after the 'Wiet Top'. The case was (and still is) very actual and relevant for Dutch students and policy makers, since the issue has not been resolved yet and was –is and will soon be[5]– front page news.

[5]New policy proposals and a heated debate are expected in second half of 2009.

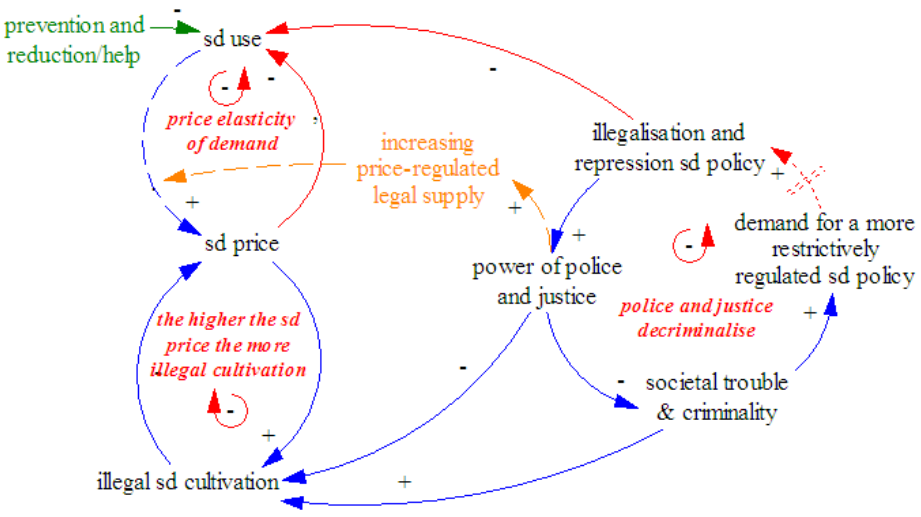

Figure 11: The synthesis policy from the aggregated point of view of proponents of more restrictive soft drugs policies

Students received a case description and guiding questions(see appendix A). The case describes the assumptions of proponents of legalising soft drugs. Students are asked to make a causal loop diagram from this description (see Figure 2), to aggregate loops in order to develop an aggregated causal loop diagram (see Figure 3), and to (mentally) simulate the model and describe its possible behaviour.

Then, students are asked to make changes to the extended and aggregated diagrams in order to model the policies proposed by their opponents, the proponents of banning soft drugs, as in Figures 4 and 5[6], and to mentally simulate the expected impact of ever more restrictive policies from the point of view of the proponents of legalising soft drugs.

A small number of students constructed causal loop diagrams that corresponded to their own mental models instead of the case description provided. Since this was an intermediate test, and not a final exam, it provided a good opportunity to discuss modeling of stakeholders' mental models versus modeling one's own mental models.

9 Conclusions and Recommendations

The policies looked at in this paper are appropriate from the points of view of their respective proponents, but are inappropriate from the opposite points of view.

An important argument against a more restricted soft drugs policy is that soft drugs will then go underground resulting in more and more loss of control. An important argument against a more tolerant soft drugs policy is that less restrictive policies are less in line with policies of neighbouring states, and lead to undesirable drugs tourism.

Although the analysis in this paper is preliminary and not completely overlapping with the analysis of the Drug Policy Commission, it seems as though policies as proposed by this Drug Policy Commission (closing front doors without (simultaneously) closing back doors) may lead to more street dealing and nuisance, less control over supply side and organized crime, and practical problems for neighbouring countries.

The synthesis policy presented in this paper does not seem to lead to the same side-effects and

[6]The dotted policy loop needs to be eliminated, and the polarity of 1 crucial link needs to be changed, changing the polarity of most loops.

seems to be acceptable from all points of views. A preliminary recommendation would therefore be to introduce regulated supply, partly closed coffeeshops, a multi-modal approach to prevention and reduction of individual harm and societal nuisance, and a war on big criminals instead of a war on soft drugs. Combined policies may thus provide a way out and solve one of the strangest gaps in Dutch law.

Qualitative System Dynamicists often try to merge different points of views in one integrated causal loop diagram. In many cases that is not necessary, for example when the debate is polarised and emotional, and policies can be determined that are appropriate from all points of views.

References

CAM (2008). Risicoschatting cannabis 2008. Technical report, Co-ordinatiepunt assessment en monitoring nieuwe drugs, Bilthoven. 2

Coyle, G. (1998). The practice of system dynamics: milestones, lessons and ideas from 30 years experience. *System Dynamics Review 14*(4), 343–365. 16, 17

Coyle, G. (2000). Qualitative and quantitative modelling in system dynamics: some research questions. *System Dynamics Review 16*(3), 225–244. 16, 17

Coyle, G. (2001). Maps and models in system dynamics: Rejoinder to Homer and Oliva. *System Dynamics Review 17*(4), 357–363. 17

Coyle, R. and M. Alexander (1997). Two approaches to qualitative modelling of a nation's drugs trade. *System Dynamics Review 13*(3), 205–222. 16

Groessler, A., M. Miller, and G. Winch (2004). Perspectives on rationality in system dynamics – a workshop report and open research questions. *System Dynamics Review 20*(1), 75–87. 17

Homer, J. (1997). Structure, data, and compelling conclusions: Notes from the field. *System Dynamics Review 13*(4), 293–309. 16

Homer, J. and R. Oliva (2001). Maps and models in system dynamics: a response to Coyle. *System Dynamics Review 17*(4), 347–355. 16, 17

Mayo, D., M. Callaghan, and W. Dalton (2001). Aiming for restructuring success at London underground. *System Dynamics Review 17*(3), 261–289. 16

Oliva, R. (2003). Model calibration as a testing strategy for system dynamics models. *European Journal of Operational Research 151*(3), 552–568. 16

Pruyt, E. (2009a, July). The Dutch soft drugs debate: A qualitative System Dynamics analysis. In *Proceedings of the 27th International Conference of the System Dynamics Society*, Albuquerque, USA. 11

Pruyt, E. (2009b, July). Making System Dynamics Cool? Using Hot Testing & Teaching Cases. In *Proceedings of the 27th International Conference of the System Dynamics Society*, Albuquerque, USA. 11

Pruyt, E. (2009c, July). Saving a Bank? The Case of the Fortis Bank. In *Proceedings of the 27th International Conference of the System Dynamics Society*, Albuquerque, USA. 11

Pruyt, E. et al. (2009, July). Hop, step, step and jump towards real-world complexity at Delft University of Technology. In *Proceedings of the 27th International Conference of the System Dynamics Society*, Albuquerque, USA. 11

Richardson, G. (1996). Problems for the future of system dynamics. *System Dynamics Review 12*(2), 141–157. 16

Richardson, G. (1999). Reflections for the future of system dynamics. *Journal of the Operational Research Society 50*(4), 440–449. 16

RIVM/AIAR (2009). De ranking van drugs. Technical report, RIVM, Bilthoven. 2

Rouwette, E., J. Vennix, and T. van Mullekom (2002). Group model building effectiveness: a review of assessment studies. *System Dynamics Review 18*(1), 5–45. 16

van de Donk, W., P. Boekhoud, W. van den Brink, et al. (2009). Geen deuren maar daden: Nieuwe accenten in het nederlands drugsbeleid. Technical report, Adviescommissie Drugsbeleid. 2

Vennix, J. (1999). Group model-building: tackling messy problems. *System Dynamics Review 15*(4), 379–401. 17

Warren, K. and P. Langley (1999). The effective communication of system dynamics to improve insight and learning in management education. *Journal of the Operational Research Society 50*(4), 396–404. 16

Wolstenholme, E. (1999). Qualitative vs quantitative modelling: the evolving balance. *Journal of the Operational Research Society 50*(4), 422–428. 16, 17

Appendices

A Hot Teaching Case Description: The Soft Drugs Summit

On 21 November 2008, a highly mediatised 'Soft Drugs Summit' ('*wiet top*') was held in the Netherlands to discuss the future of the Dutch policy of tolerance related to soft drugs, also known as '*het gedoogbeleid*'. Nowadays, there are about 700 '*coffeeshops*' (soft drug bars) in The Netherlands. They have been tolerated since 1976, the year in which the then Dutch government decided to separate soft drugs and hard drugs in order to get soft drugs out of the underworld (the criminal circuit). At that time, it was clear that rules and regulations about the supply of these coffeeshops had to be made after some time. However, the supply of these coffeeshops has never been regulated. All activities related to the supply of coffeeshops are consequently illegal, but some activities are winked at.

Nowadays, most Dutch citizens and policy makers agree that this policy of tolerance needs to be revised. Dutch society is nevertheless strongly divided about the direction of the revision. Currently the Dutch soft drug debate is –broadly speaking– dominated by two groups (splitting the cabinet, opposition, and population) with almost opposite points of views:

- The proponents of a stricter soft drugs policy want the abolishment of *het gedoogbeleid*, the closing of coffeeshops, and more severe punishments for soft drugs trade and use.
- The proponents of a better regulated but looser soft drugs policy want the further legalising of soft drugs cultivation and use, or at least the regulation and legalisation of the supply of coffeeshops, and only the closure of coffeeshops causing serious nuisance. They argue that banning soft drugs will only pass soft drugs cultivation and trade into criminal hands and will therefore not resolve soft drugs-related problems.

.

Since you are (becoming) a *causal loop diagram* expert, you are invited to join a meeting of proponents of a further legalising of soft drugs cultivation and use in order to map their ideas in a causal loop diagram. At the meeting, following opinions/ideas are expressed:

A policy of more *illegalizing and repression* leads –according to the proponents of a further legalisation– to more *illegality of soft drugs cultivation, sales and use*, which, ceteris paribus, results in an increasing *soft drugs price*, more *street dealing* and more *small criminality*. More *street dealing* and *small criminality* leads immediately to more *societal nuisance*.

An increasing *soft drugs price* leads to an increasing *profitability of illegal soft drugs business*, which results –after some time– in an increase of the *size of the illegal soft drugs business*. The

proponents of a further legalisation assume that an increase of the *size of the illegal soft drugs business* leads after some time to an increase in the (financial) *power of soft drugs criminals* [or 'business men'], which in turn results in an increase of *heavy criminality* [or at least black money].

Both an increase of *societal nuisance on the street* and an increase of *heavy criminality* leads to more *societal resistance against the illegal soft drug business*, which leads to a *stronger call for more soft drugs policy*.

It is often assumed by proponents of legalization that an increasing *illegality of soft drugs business and use* lead to an increasing *attractiveness of occasional soft drugs use*, which leads to an increasing *soft drugs use*, both directly and indirectly (an increase of the *attractiveness of occasional soft drugs use* leads after some time to an increasing *addicted soft drugs use*). The *soft drugs use* drives the *soft drugs demand*. An increase of the *soft drugs demand* leads, ceteris paribus, to an increase of the *soft drugs price*.

An increase in the *size of the illegal soft drugs business* leads to an increase of *illegal soft drugs cultivation*, that in turn increases *total soft drugs supply*. An increase of the *total soft drugs supply* leads, ceteris paribus, to a decrease of the *soft drugs price*.

The proponents of a further legalisation of course think that increasing calls for *calls for more soft drugs policy* should lead to more policies focussed on decreasing the *illegality and repression*, which means (more) *legal soft drugs cultivation* such that the *total soft drugs supply* increases in a legal (and controlled) fashion, and more *control over coffee shops* which means less *societal nuisance caused by coffee shops* (dotted lines).

1. Summarize the ideas of the proponents of a further legalisation in an extended causal loop diagram.

2. How many feedback loops does this extended causal loop diagram contain if you take the link between *demand for soft drugs policy* and *illegalization and repression* as well as the policy of *legal soft drugs cultivation* into account?

3. Mentally simulate the model. What behaviour will the system display with this policy if it can be assumed that a decrease of the *illegal soft drugs cultivation* will be more than compensated by an increase of the *legal soft drugs cultivation* such that the *soft drugs price* will not increase significantly. Sketch the expected system behaviour.

4. Make an extremely aggregated causal loop diagram that would allow you to explain the link between structure and behaviour of this system in about 30 seconds to politicians and laymen.

5. Describe this link between structure and behaviour of this system in maximum two sentences.

6. The opponents of a further legalisation argue that an increasing *demand for soft drugs policy* needs to be answered with stricter policies (more *illegalization and repression*). That also means that legal soft drugs cultivation is unacceptable. Use another color to indicated on the extended causal loop diagram how that changes the structure of the extended causal loop diagram. The adapted diagram represents the policy of the opponents of a further legalisation from the point of view of proponents of a further legalisation (which should not be confused with the policy of the opponents of a further legalisation from their own point of view).

7. Mentally simulate the model. What behaviour will the system display with this policy if you assume/accept that –in case of an increasing soft drugs price– illegal soft drugs cultivation will never increase to such an extent that the soft drugs price will decrease significantly. Sketch the expected system behaviour.

8. Make an extremely aggregated causal loop diagram that would allow you to explain the link between structure and behaviour of this policy & system (the policy of the opponents of legalisation from the point of view of the proponents of a further legalisation) in about 30 seconds to politicians and laymen.

9. Describe this link between structure and behaviour of this system in maximum two sentences.

10. List two important assumptions specific to the world view of the proponents of a further legalisation (not shared by opponents).

B Qualitative versus Quantitative System Dynamics

Proponents of isolated qualitative System Dynamics modeling argue that if a close representation cannot be reached, the analysis should be restricted to the qualitative level (Coyle 2000) and that qualitative System Dynamics modeling is satisfactory when the 'insights from the diagram are so convincing [or] uncertainties in the numerical data are so great that a quantified model may contain such uncertainties and inaccuracies that it is not worth the effort of building' (Coyle and Alexander 1997, p206). Other arguments pro qualitative modeling are that qualitative System Dynamics is useful

- for describing a problem situation and its possible causes and solutions, potential risks (Wolstenholme 1999, p424) and uncertainties[7], hypotheses and constraints,
- to 'capture intricacies of circular causality in ways that aid [...] understanding' (Richardson 1999, p441) (Wolstenholme 1999, p424),
- as a medium by which people can externalise and share their mental models and assumptions (Wolstenholme 1999, p424), (iv) for the 'inference of modes of behavior by assisting mental simulation of maps' (Wolstenholme 1999, p424),
- to show people the dynamic system they are part of, the strategic ramifications, and to propose solutions (Coyle 2000). As such it could create a common language and understanding of the structure and the feedback loops, reveal the big picture, hidden and different world views, hypotheses, constraints, structural problems (boundaries), uncertainties, threats, risks, opportunities, possible leverage points, policy variables and policy structures, and could therefore be seen as a problem structuring and discovery tool. A good example of qualitative system dynamics is (Coyle and Alexander 1997) who combine the qualitative System Dynamics influence diagram technique with the rich picture technique from Soft Systems Methodology to get a better grip on intractable problem messes.

Some arguments against purely qualitative modelling are that

- maps could be misleading (Richardson 1999, p441) and may be 'unreliable tools for behavioral inference' (Homer and Oliva 2001, p349) (Richardson 1996),
- they do not enable estimation of 'the scale or speed of change of key items' (Richardson 1999, p442) (Warren and Langley 1999),
- 'feedback based insights, especially those based on multiple loops of uncertain strength, can often be difficult things for people to understand and believe in' (Homer 1997, p307),
- they are 'less likely to lead to commitment, consensus or system changes than quantitative models' (Rouwette, Vennix, and van Mullekom 2002, p32), and
- they are but 'tools for hypotheses generation without the systematic approach to falsify the hypothesis' (Oliva 2003).

(Coyle 1998, 357) (Coyle 1998) agrees that '[t]o be sure, it is impossible to predict the dynamics from a diagram, but it may be that there are circumstances when it would be irresponsible to attempt to do so from a simulation model that might be little more than ill-judged guesswork'.

[7] uncertainties due to soft variables, parameter uncertainty, model uncertainty, and uncertainties related to different structural options and leverage points (Mayo, Callaghan, and Dalton 2001, p269))

Opponents of purely qualitative modelling argue that simulation nearly always adds value (Homer and Oliva 2001, p347) while most system dynamicists seem to agree that quantitative System Dynamics demands a deeper and more rigorous analysis than qualitative mapping (Wolstenholme 1999, p424).

Some arguments against the application of quantitative simulation in all circumstances are that

- quantification might sometimes not add to understanding an issue (Vennix 1999, p391-392),
- there is a 'tendency to produce models which are too detailed and complex to sufficiently validate them against the mental models of their creators' (Wolstenholme 1999, p424),
- the models are nothing more than idealised representations of the world constrained by the restrictive nature of the feedback loops, stocks and flows (Wolstenholme 1999, p424),
- they are speculative if data are unavailable (Wolstenholme 1999, p424), and even risky in case of 'multiple and poorly understood soft relationships' (Coyle 2001, p357)[8], so that quantification of 'models could well involve so many compounding and unknown uncertainties that the results, modelling skill and sensitivity analysis notwithstanding, might be so uncertain as to be misleading' (Coyle 1998, p356-357), and finally
- quantitative operations on qualitative and/or soft variables are not theoretically sound: since the internal operations of quantitative System Dynamics models and their simulation are ratio-scale operations, the input data of System Dynamics models need to be of the ratio-scale type as well, which –from a theoretical point of view– renders the use of qualitative, soft variables and ordinal data impossible.

Just as there is no conclusive theoretical argument for purely qualitative or purely quantitative system dynamics, there is 'little empirical evidence for the added benefit of analysis with simulation versus analysis without in specific situations' (Groessler, Miller, and Winch 2004, p84).

The major group of moderate mainstream system dynamicists hardly interfered in this discussion, because of their pragmatic point of views. They often start with qualitative System Dynamics, then turn to quantitative System Dynamics which results are interpreted in a qualitative sense and communicate the results back using qualitative System Dynamics, and that in a single intervention.

The authors of this paper are also mainstream in that sense: about 90 per cent of qualitative models are subsequently turned into quantitative simulation models. The case of the Dutch Soft Drugs Debate belongs to the remaining 10 per cent for which it could be argued that a purely qualitative System Dynamics approach is most appropriate.

[8] E.g. the multiplication of 'soft' variables (Coyle 2001, p359-360) and the serious risk of double counting (Coyle 2000).