"When we understand that slide, we'll have won the war"
– peace support modelling with the use of the MARVEL tool

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Keywords

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English summary

This report documents a study for the FFI project The Future Land Power, on the modelling of peace and stabilisation operations. The study was carried out in the period from June 2010 to August 2011, in collaboration with The Netherlands Organisation for Applied Scientific Research (TNO), and had two main objectives:

1) Analyse the effect of different Norwegian land force contributions in peace and stabilisation operations abroad, related to the Future Land Power project.
2) Test and evaluate the MARVEL tool and provide feedback to TNO.

The two objectives are documented separately. The main body of the report primarily documents the first objective, whilst our findings with regard to the second objective are documented in an appendix.

We were unable to fully reach the goals set for the study. While we managed to test and evaluate the MARVEL tool, we were not able to solve the analysis problem for the Future Land Power project, and we did not provide an answer to the principal research question for the study: What is the impact of different Norwegian force contributions to peace and stabilisation operations, and how can these differences be measured? In the report we have discussed the most likely reasons for this.

Even though the study failed to meet one of our objectives, much was learned from the work. This is why we chose to write this report.

Sammendrag

Denne rapporten dokumenterer en studie av stabiliseringsoperasjoner gjennomført i FFI-prosjektet "Fremtidens landmakt" fra juni 2010 til august 2011. Studien har blitt utført i samarbeid med nederlandske TNO og hadde to hovedmål:

- Analysere effekten av ulike norske landstyrkebidrag i stabiliseringsoperasjoner, som en del av prosjektet Fremtidens landmakt.
- Teste og evaluere verktøyet MARVEL og gi tilbakemelding til TNO på dette.

Hoveddelen av rapporten dokumenterer den første målsettingen, mens resultatene i forhold til den andre målsettingen er dokumentert i appendix.

Målene for studien ble ikke fullstendig nådd. Vi fikk testet og evaluert MARVEL-verktøyet, men vi klarte ikke å gi et svar på hva effekten av ulike norske styrkebidrag i stabiliseringsoperasjoner er. I rapporten har vi drøftet hvorfor dette målet ikke ble nådd.

Selv om analysene ikke ga svar på våre opprinnelige spørsmål, har vi lært mye av å gjennomføre studien. Det er også nyttig å dokumentere ikke helt vellykkede arbeider på samme måte som suksesser, og det er med dette utgangspunktet vi har valgt å skrive denne rapporten.

Contents

1   Introduction

The goal of the FFI project The Future Land Power[1] was to analyze future requirements for military land power in a national, allied and multinational context, and to support the Chief of the Army and the Chief of the Home Guard in their functions as military advisors. An analysis of the future requirements for military land power has to consider several factors, including the tasks and challenges involved with operations abroad. The project completed its work early 2012.

FFI also participates in the Anglo Netherlands Norwegian Collaboration Project (ANNCP). One goal of ANNCP is that the participating nations exchange studies and tools and collaborate in projects. Over the last years, The Netherlands Organisation for Applied Scientific Research (TNO) has developed a Method to Analyse Relations between Variables using Enriched Loops (MARVEL). Based on this method, TNO has developed a tool that aims to bridge the gap between simpler and more advanced approaches for system dynamics modelling. Both UK and Norway showed an interest in the tool, and TNO agreed to let the partner nations test it, as long as they provided evaluations and feedback for the continued development of MARVEL.

This report documents a study related to the two projects mentioned above, performed in the period from June 2010 to August 2011. There were two objectives of the study:

- Related to The Future Land Power project, to analyse the effect of different Norwegian land force contributions in peace and stabilisation operations abroad.
- Related to ANNCP, to test and evaluate the MARVEL tool and provide feedback to TNO.

Naturally, the bridge between the two objectives was the MARVEL tool. The researchers involved in the activity tried to use MARVEL to develop a model in support of the land power analysis, and the experiences from this activity were to be documented and provided to TNO.

It is fair to say that we failed to meet the first objective. For several reasons, we were unable to develop a model that gave any solid answers to the question of which Norwegian force contributions are best suited for peace and stabilisation operations. This is likely not related to any inherent flaw in the MARVEL tool. Rather, it can be assumed that the framework for and the choices made during the analysis weren't always the optimal ones. It is also possible that the research questions raised in the analysis are more or less impossible to answer with the chosen approach. This is subject to some discussion in the latter half of the report.

Even though the output of the analysis failed to answer our initial questions, much was learned by performing the analysis. This is why we chose to write this report.

Although the two objectives of the study were clearly related, we found that documenting both in parallel made for a slightly schizophrenic reading experience. To provide a clearer report

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[1] In Norwegian: Fremtidens landmakt.

structure, we decided that the main body of the report should primarily cover the first objective, not least because this objective was deemed to be of more general interest than the methodological evaluations. Because of this, our findings related the second objective is documented separately in Appendix A.

The structure of the report is as follows: The research questions and problem formulations are discussed in Chapter 2. Chapter 3 briefly describes the theory behind MARVEL, and the modelling process used in this study is presented in Chapter 4. In Chapter 5, we discuss our experiences from the modelling process. Chapter 6 presents some final thoughts from the work. Our experiences with MARVEL are presented in Appendix A.

2　Research questions and problem formulation

Norwegian Armed Forces have regularly participated in military operations abroad after World War II. Participation has been a priority in order to i.a. meet international commitments and, more recently, contribute to NATO cohesion and relevance. While all service branches have been involved, the contributions of land forces from the Army have been significant. They have deployed battalion-size formations (for instance in Gaza, Lebanon, Bosnia and Afghanistan), company-sized formations (for instance in Kosovo) and special operations forces [1]. Until the mid-1990's, Norway contributed heavily to traditional UN peacekeeping missions. During the last decade, the character of international operations has changed. In addition to the UN, regional organisations, such as NATO, have become more involved as well, albeit often with a UN mandate. In the last decade, the term *peace and stabilisation operations* has been used to describe these military operations.

FFI has over the years developed a methodology to analyse the effect of different force structures in a given operational setting. Usually, this is done with regard to challenges against Norway's territorial security, where success can be measured relative to our Armed Forces' ability to meet and counter direct military threats. Less analytic consideration is given to participation in international operations.

Given Norway's emphasis on participating in international operations, and with the recent experiences with peace and stabilisation operations in mind, a relevant question is:

- How can we analyse the effect of different Norwegian land force contributions in peace and stabilisation operations abroad?

In many ways, this is a messier and more complex problem than the territorial analyses discussed above. In an international operation, Norwegian forces operate in a multinational coalition with a complex set of purposes and goals. There are many (and often conflicting) opinions on what the most important criteria for success are. Still, a common view is that success has to be measured in other ways than just looking at the outcome of direct military combat. Examples of other relevant parameters are population support for the local government, good local governance, economic

development and the perceived security of the local population. Singling out the impact of Norwegian force contributions to such variables is not trivial, not least given the myriad other actors operating in the theatre: Coalition forces, local security forces, humanitarian organisations, non-governmental organisations, etc. There are numerous interdependencies between all the involved actors and their actions. Decisions made and actions taken from all involved parties influence on the situation, but more often than not it is hard to say just how strong the impact is or how soon the effects can be observed, beyond uncertain, qualitative 'guesstimates'.

A slightly more realistic (or even cynical) view is to say that it is a hopeless task to optimize Norwegian force contributions to the overarching goals of a stability operation. Given that Norway's contributions have to be picked from a force structure that has been developed primarily with territorial challenges in mind, some will argue that the most important success criterion is that we are able to offer relevant forces to an international coalition at all. International contributions often have to be tailor-made by combining parts of several existing units, with potential disruptive effects for those affected. This also means that the differences between possible force packages within the context of the current contributions are likely to be small, further reducing the need to optimize them relative to the high-level operational goals.

There is a possible middle way, though:

- Instead of optimizing the composition of Norwegian force packages, it should be easier to study which principal tasks the forces have to work with once they are in the theatre. Should they primarily be prepared for direct combat operations or supporting and training local actors (for instance, mentoring local security forces)?
- Instead of looking at high-level coalition goals, the impacts of Norwegian forces should be measured relative to the local area they operate in.

Even with these limits, this is still a highly dynamic and complex problem, with numerous causal loops and interdependencies. As such, it has many of the hallmarks of a research problem that can be studied with system dynamics modelling. The lack of good quantitative data means that more advanced forms of system dynamic analysis are unlikely to work, while very simple causal models will be too static to offer any useful answers. However, this is exactly the kind of analysis for which MARVEL offers opportunities. Subsequently, we chose to try to use MARVEL for our analysis.

The chosen approach has some similarities with a well-known attempt at modelling COIN dynamics in Afghanistan. A causal diagram of the interdependencies between relevant aspects for securing stability in Afghanistan, and how different coalition actions could impact on the population's support to either the local government or the insurgency, was presented to the then ISAF Commander, General Stanley McChrystal, in the summer of 2009. According to news reports, when the general was shown the complex slide, he commented: "When we understand that slide, we'll have won the war" [9]. The causal diagram, later labelled "the spaghetti slide", is shown in Figure 2.1.
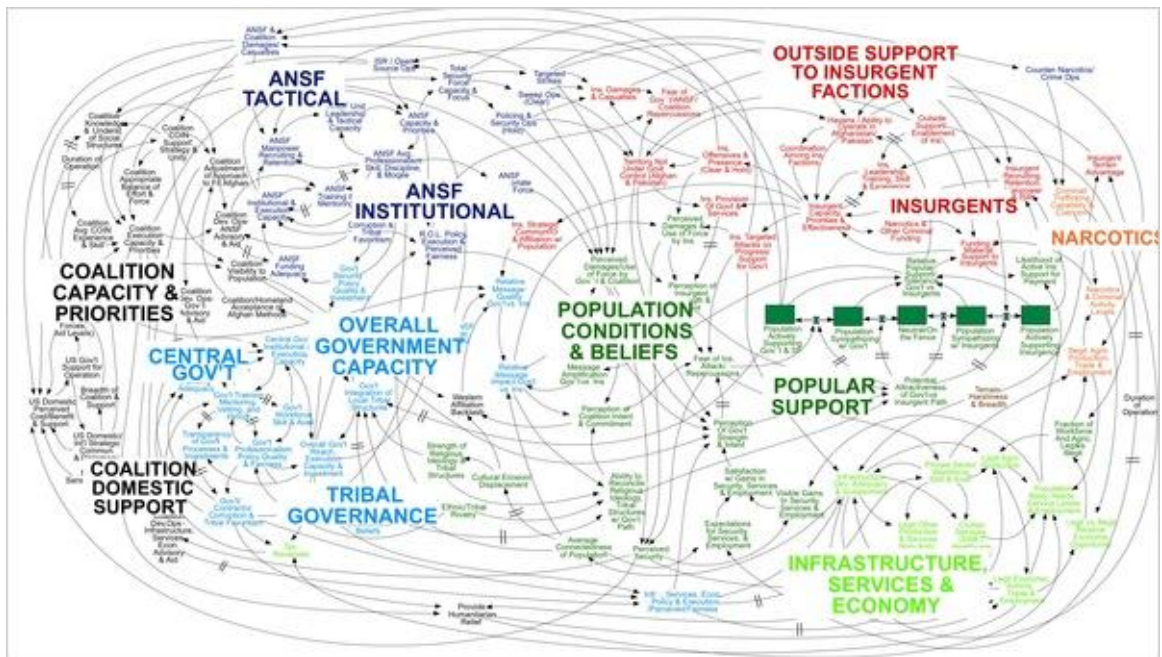
Figure 2.1   "The Spaghetti Slide": Causal model of COIN dynamics in Afghanistan[2].

Much of the discussion that followed the publication of the slide was related to the use of PowerPoint in the military. Regarding the model itself, responses have been varied: Some say it is a useful attempt at showing how all things are interconnected in conflicts, that warfare is more than just killing the opponent. Others say that it represents an assault on logic or that it is a vain attempt at predicting the unpredictable [10].[3] It has to be said we met many similar comments when we worked on our own analysis.

3   Theory: The MARVEL approach

The Method to Analyse Relations between Variables using Enriched Loops (MARVEL) is developed by TNO. The method was developed in order to help analysts obtain insights into the effects of policy interventions in complex systems over time [2]. Such problems often have feedback loops between variables and time delays that impact on the system behaviour, making it hard to predict the effects of changes.

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[2] Developed by PA Consulting Group.
[3] It is fair to add, though, that the published slide itself was never meant as a standalone briefing document, but was part of a bigger analysis process.
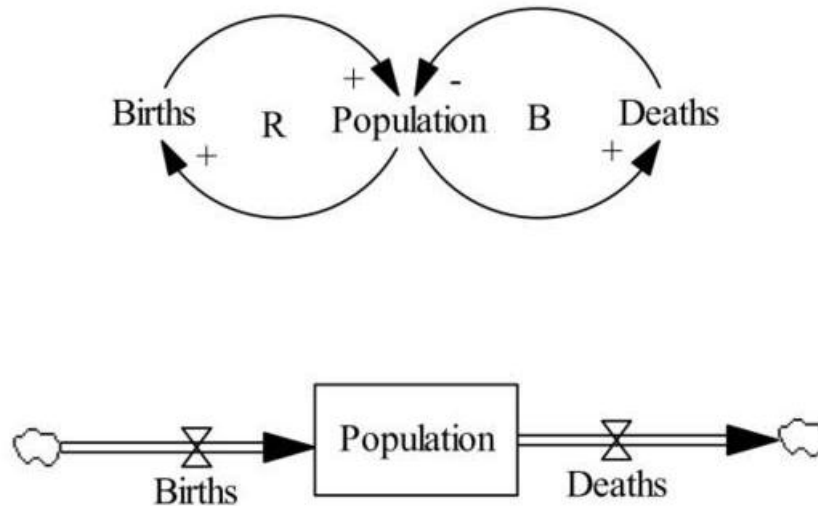
Figure 3.1   Examples of CLD (top) and SFD (bottom).

Several system dynamics approaches are relevant for such problems. A simple approach is to draw an influence diagram, often referred to as a Causal Loop Diagram (CLD), which is a qualitative visual representation of a problem and its feedback loops (see Figure 3.1). While good for problem structuring purposes, a CLD offers limited opportunities for analysis, since it basically gives just a static visual representation of the problem.

Another approach is Stock and Flow Diagrams (SFD, see Figure 3.1), where the problem is modelled as a number of stocks (entities that can change in value over time by accumulating or depleting) and flows (the rate of change between stocks). Stock values characterise the state of a system and provides the information upon which decisions are based. Any decision made alters the flow rates, which again alters the stocks over time. A SFD usually needs quantitative data and sound numerical calculations to predict how the system develops over time, and they are often time consuming to develop [2, 3, 4].

MARVEL aims to fill the gap between the two previous approaches. It offers more (qualitative) analysis opportunities than a CLD, but less effort than a fully quantified SFD, and it aims to be useful in group model building processes where stakeholders explore policy interventions in problems with limited quantitative data available [2].

The starting point for a MARVEL-supported analysis is to develop a CLD, where intervention points (control variables) are mapped to objectives (goal variables) through a series of variables and feedback loops. After this is done, the relations between the variables are evaluated by the stakeholders. More specifically, the stakeholders have to assign values to the speeds and strengths of the causal relations between the variables in the model. After this is done, it should be possible to run the model and gain insight into the first effects of different policy interventions. An example of a simple MARVEL model is shown in Figure 3.2, where the control variable (usage of pesticides) impacts on a goal variable (damage to crops) through a couple of other variables.
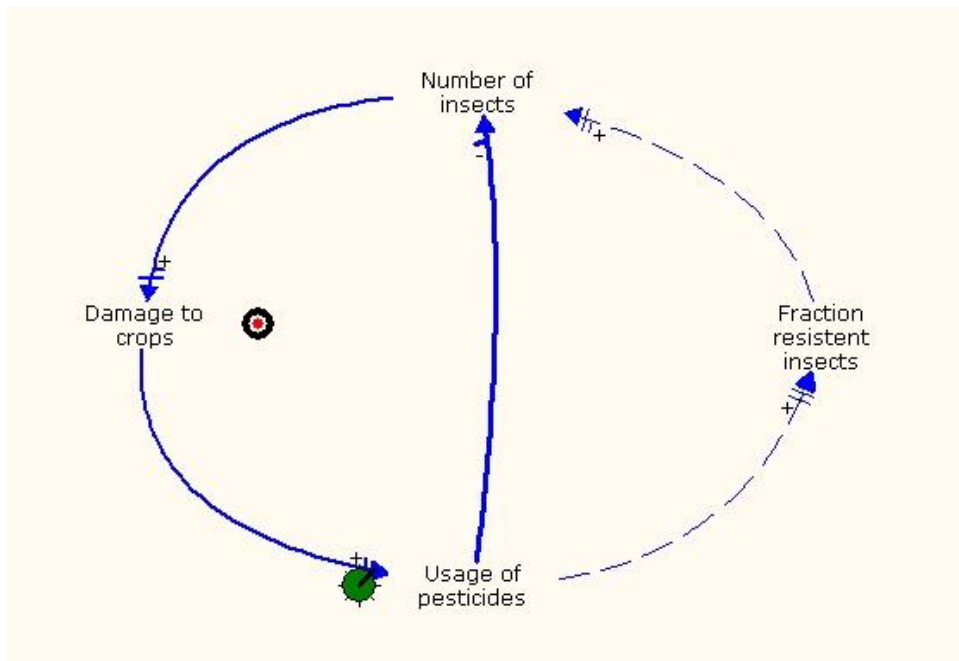
Figur 3.2   Example of a model in MARVEL[4].

A MARVEL analysis can provide the following results [2]:

- Insight into and consensus on the problem structure.
- Insight into the relative power of identified feedback loops.
- First insight into the problem's behaviour over time.
- First insight into the expected effects of proposed interventions.
- First insights into the better interventions to propose.

More information about MARVEL can be found at TNO's web pages at http://www.tno.nl. [5]

4   Peace support modelling

4.1   Work process

Our study for The Future Land Power project was carried out as a combination of group sessions with experts (referred to as workshops in the report), and work done in the office between the sessions by a small team of researchers. In total, three workshops were held during the study in July 2010, October 2010 and February 2011. The different parts of the process are presented briefly in the following sections.

The analysis problem depended on input from several disciplines. FFI houses expertise in many fields, covering a lot of the necessary areas for this study: Military theory, international

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[4] The example is from a presentation of the MARVEL tool by Sanne Heesmans (TNO): *Effect assessment in an operational environment*, presented at FFI July 2010.

operations in general, Afghanistan in particular, operational analysis, etc. On the other hand, there are several relevant areas that are not covered by FFI, for instance humanitarian efforts, economic and infrastructure development, etc. We considered inviting relevant outside experts to participate in workshops, but in the end this was ruled out because of the parallel MARVEL evaluation. In short, as we were exploring the tool and the approach ourselves, it would be premature to involve outside expertise as well. In the end, the workshops involved participants from relevant FFI projects, in addition to support from TNO during two of the workshops.

The first part of the work was to describe and structure the research problem. Problem structuring is important to gain a common understanding of the problem by all participants. Initial work on this was done by the research team with some support from TNO, after which the problem was brainstormed with experts during the first workshop. The results of the problem structuring are discussed in Chapter 4.2.

After the initial problem structuring and problem definition phase, the most relevant parts of the problem were identified. An important part of the work was to develop a CLD of the chosen problem, with relevant variables and causal links. The workshops were used to discuss and develop the model with the experts, and goal and control parameters were identified along with the speeds and strengths of the most important causal relations. Ideally, all the strengths and speeds of the causal arrows should have been specified in the workshop session. Because of time constraints, some work had to be done by the research team and were only briefly discussed in the workshop sessions. The running and testing of the model was also done only by the research team. The model is presented in Chapter 4.3.

4.2 Problem structuring

As discussed in Chapter 2, the relevant research question for the study was:

- How can we analyse the effect of different Norwegian land force contributions in peace and stabilisation operations abroad?

There is no easy way to answer this question, but one starting point is to specify and discuss a subset of problem areas related to the overarching problem formulation. Through a brainstorming session we defined the following questions:

- What are the constraints for the work?
- Which different force contributions should be compared?
- What kind of operations should we study?
- What parameters should we measure on, and on what level?
- What are the goals we want to reach, and what are our control variables?

These questions are discussed below.

4.2.1   What are the constraints for the work?

There were several constraints and limitations for the work done in this study. Three of the most important are discussed here.

The study had *limited resources* available. The principal participants were two researchers working part-time. Due to other obligations, the analysis work had to be spread out over a long time period (over a year), which reduced the momentum for the work.

The study was to be done with a *method and tool little known to the researchers.* The researchers had to test and evaluate the MARVEL tool as part of the study. Although support was available from TNO, it is fair to assume that some choices made in the modelling and work process would have been different had the researchers fully mastered the method and tool before the work started.

For several reasons, but not least related to the long duration of the study, it proved *impossible to have the same group of experts* as participants in all the workshops. Some experts were involved through the whole process, while others were just present for one or two workshops. Establishing a common understanding of the method, research problem and work process proved hard because of this.

4.2.2   Which different force contributions should be compared?

Given that the study was to be done for The Future Land Power project, one immediate limitation was to exclude contributions from air and maritime components, and just look at forces related to the Norwegian land component. For our study, this also meant that the differences between force packages were likely to be small when it comes to numbers and equipment, since they were all collected from the same, relatively small pool of forces.

4.2.3   What kind of operations should we study?

As discussed in Chapter 2, the character and mandates of military operations abroad have changed over the past few decades. An important question was to determine if we should use a case for the analysis, and if so, what kind of operation we should study.

Over the latest decade, the most significant Norwegian land force contribution abroad has been to the NATO-led International Security Assistance Force (ISAF) in Afghanistan, the main effort being about 350 soldiers [6] to the Provincial Reconstruction Team (PRT) in Maimanah. FFI has also been represented in Maimanah with a deployed operational analyst during the past four years. This made the current operations in Afghanistan a natural case for the analysis.

Whether this was a particularly *good* case was subject to some discussion initially. One objection was that Afghanistan was unlikely to be representative for the future international operations Norway will participate in, and that the challenges faced here are not the ones we are likely to

face in the future.[5] Also, Norway is currently – together with other nations – reducing its forces in Afghanistan, so any findings from the study would have little (if any) impact on the current operation. Following this logic, using Afghanistan as a case would at best have us plan for the present, at worst for the past, and possibly not be relevant at all for the future. Other relevant scenario classes for Norway's future international operations are discussed in more detail in [7].

While these objections are certainly both valid and important, in the end Afghanistan was chosen as the case anyway. The deciding factor was the amount of knowledge and data available about the Afghanistan operation and its challenges, both in the Armed Forces in general and at FFI in particular. Since the study depended on a tool and a methodological approach that was new for FFI, it was seen as important to select a case where input data was available, even though much of the data was of a qualitative nature. Also, it can be argued that even though there are strong incentives to avoid such a large and extensive military operation as in Afghanistan in the future, the challenges faced by the Norwegian forces locally may be representative also for future operations.

4.2.4   What parameters should we measure on, and on what level?

How to decide that one specific force contribution is better suited than others? This was also subject to some debate at the start of the study. A starting point for the analysis was to consider the ISAF mandate and the aims listed there. A stripped-down version of these aims is as follows [8]: Conduct stability and security operations, assist in the development of Afghan National Security Forces (ANSF), identify reconstruction needs, support the disarmament of illegally armed groups, and support local anti-narcotics efforts and humanitarian assistance. While Norwegian forces certainly contribute to the ISAF aims, it would be hard to claim that success on the coalition level hinges on Norwegian efforts, or that different Norwegian force packages are better suited than others for the coalition's ability to reach the goals. In other words, the distance between the goals and the measures was too large.

Another option would be to look specifically at the local province where Norwegian forces operate (Faryab) and study their contributions there. Instead of looking at the macro-level goals, we used the first workshop to have our experts brainstorm about aspects of security that would be important for the local population.[6] The initial list was:

- prosperity
- basic services
- economic development
- social services
- freedom to make a living
- infrastructure

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[5] For instance, one recent example of Norwegian international participation is Operation Unified Protector, the NATO-led air campaign in Libya during the spring of 2011. There are few similarities between this operation and Norway's contributions in ISAF.
[6] First internal workshop, July 10th 2010.

- a functioning state
- education
- markets
- perceived security

While the list is neither sorted nor complete, and while many of the bullet points overlap (for instance "basic services" and "infrastructure"), it shows some of the limitations of military force in peace and stabilisation operations. Many of the listed bullet points are related to economic, societal and infrastructure development, traditionally tasks outside the military responsibilities.[7] The one parameter where military force was seen to have the most direct implications is "perceived security", which was chosen as the variable by which to measure impacts of different force packages. So in the end, our task was to relate the impact of different Norwegian force contributions on the perceived security of the local population in Faryab.

4.3 Final version of the model

The model went through several iterations over the year the study lasted. The causal model for the last iteration is presented in Figure 4.1.
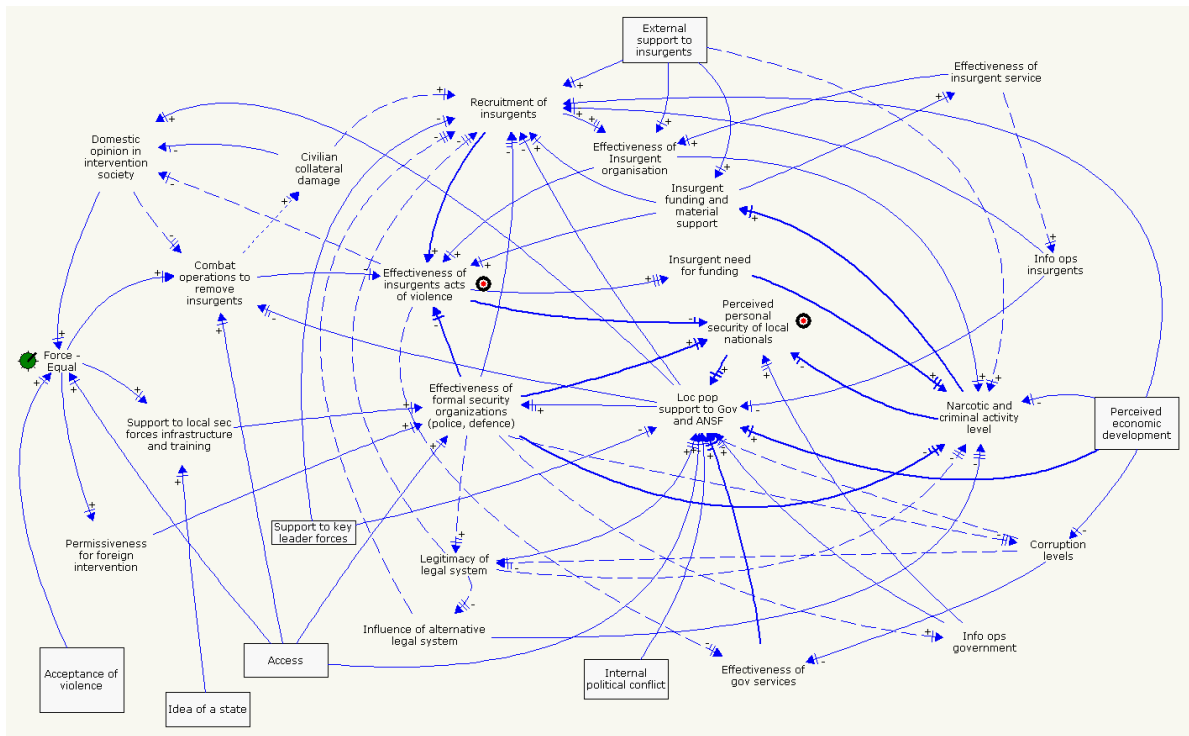
Figure 4.1   Final version of the model.

It is beyond the scope of this report to describe the model and all its variables and causal links in detail. Simply put, the model attempts to study the impact of changes in the priorities for the

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[7] FFI has in cooperation with the Provincial Reconstruction Team Maimanah developed a survey to be held in Faryab, Afghanistan. These bullets reflects to a large degree what the population themselves consider as important. See for instance [11].

Norwegian forces on the local security situation, which again depends on the actions of insurgents and local security forces operating in the area.

It is important to stress that the MARVEL approach aims to study how policy changes spreads through a system. For us, this meant that different force packages had to be represented as a change in policy, with a value between 0 and 1, in order to be used in the model. So how does one represent Norwegian force structures with just a number, and what do the chosen values mean? A few possible approaches discussed during the analysis were:

- Represent each force element in the total package as a control variable. These would be given the values 0 (element not present), 1 (element fully present) or somewhere in-between (element partly present). The relative impact of each element in the model could be represented by the speed and strength of causal arrows. While possible, it was seen as a challenge to decide on which level the different elements should be represented. Depending on the level of detail, there could also be many elements, making the causal model messy.
- Decide on a maximum quality of a force package given the value of 1, and relate contributions with lesser quality on the scale from 0 to 1. It was deemed that this approach would likely just give the answer that the maximum contribution would be the best anyway, given that there were no good ways to study different task assignments and principally different contributions within the packages.
- Look beyond the force structures and rather study the tasks that Norwegian forces should work with in the theatre. Basically, this meant that we would try to find the optimal balance between the principally different approaches Norwegian forces could follow, for instance between a combat oriented and a support oriented approach. The current Norwegian approach in Faryab could work as the starting point, with values for different tasks on the 0 to 1 scale. After this, we could see how changes from this approach (with more or less effort put into different tasks) would impact on the local security. Should the changes lead to better results for the goal variables, we would later have to translate the "optimal" task balances to relevant force contributions.

In the end, we chose the latter approach. In the model, the Norwegian forces (the control variable, labelled as "Force – Equal" to the left in Figure 4.1) can influence two principal tasks, "Combat operations to remove insurgents" and "Support to local security forces' infrastructure and training". If the contribution of Norwegian forces influence on the local security situation, changes in their task priorities should have impact on the goal variables, "Perceived personal security for local population" and "Effectiveness of insurgents' acts of violence".

In addition to the strong central loops related to insurgents and local security forces, other variables in the model relates to local criminal levels and the legal system. While the model primarily relates to the local situation in Faryab, several rectangles are added around the model to show that local security also depends on outside factors (for instance, external support to the insurgency, cultural factors and the general economic situation).

5   Experiences from the modelling process

In the end, our approach and the developed model did not provide us with clear answers. Even radically different inputs into the model did not produce significantly different effects on the selected goal variables. In other words, during our initial trials with the model, the tasks of the Norwegian forces did not seem to matter for the security of the local population. Because of this, work on the model stopped before it was completely finished.

There are many possible reasons for this result. In this chapter, we discuss this with regard to the challenges in the modelling and analysis process.

5.1   Modelling challenges

There were a lot of challenges in the modelling work. The sum of these challenges may have lead to a flawed model, not providing a good representation of the real problems. Some of these challenges are discussed below.

Keeping the analysis local was a huge challenge. Discussions with experts invariably lead us to problems relevant for the ISAF level (and even beyond), not just for the local Faryab province. This is not surprising, given that it is very difficult to distinguish between local and global effects. The local security situation also depends on causes outside of the area.

It was difficult to draw a strict line between variables that had to be included in the model and be subject to influence from Norwegian force policy changes, and those variables that could be seen as *static external influences*. In the model in Figure 4.1, some static external influences are marked with rectangles and added to the edges of the model. These influences likely have a large impact on the results, but this was not studied in detail because of time restrictions.

In any modelling exercise, there is a danger of *suboptimal modelling*, where parts of the problem are well (even too much) represented, while others are handled with too little detail. The quality of the model depends on many factors, not least on which experts are available and how the problem is structured. The model we ended up with likely leans too heavily towards modelling the local security situation as a battle between insurgents and local security forces, which makes up the strong central core of the model. Effects from other variables (for instance, legal systems) and external factors (for instance, economic development) are less accounted for. The strong central core has a few dominating variables which likely cancel the effect of each other, which explains why there was little change observed even with radically different policy inputs.

It is also important to add that the complexity of the research problem makes it *hard to develop a good causal model*. It was quite easy to identify relevant variables and say that there were causal links between them. However, for most of the causal relations, we found that we could easily argue that the influences could go either way, or that strengths and speeds would vary with different conditions.

This leads to a danger of modelling based on *self-enforcing truths,* where influences are modelled based on the researchers' own hypotheses of where the causal effects are the strongest. The fundamental logic in this model is that the perceived local security increases if the insurgency levels go down and the local security forces are more effective. This may seems logical for a Norwegian researcher in an office far away from the study area; whether this is also true for the average inhabitant in Faryab is certainly up for discussion. The way we chose to minimize the effects of this issue this was to have a broad range of subject matter experts involved in the workshops to verify the model, but it proved impossible to cover all relevant disciplines in the end, cf. Chapter 4.1.

Finally, it must be added that there are few, if any, known comparable works to our study, besides the ISAF model discussed in Chapter 2, at least in open sources. Thus, it would have been difficult to *verify the results* from the model with other works.

5.2   The analysis process

Each of the workshop sessions were fruitful and gave good inputs to the modelling process. It is generally useful to involve experts from different disciplines in group discussions, and we found that the MARVEL approach offered a good framework for having a structured discussion. By looking at relevant variables and their interdependencies, discussions soon went from the general to the specific, and the experts offered relevant insights from the different disciplines involved. For the purposes of problem structuring and transfer of knowledge, the approach had many benefits.

One observation is that it is hard to create a complete model just by expert discussions, especially for such a complex problem as the one we worked with. This has several likely causes:

- Opinions about the effects and interdependencies between variables differed, not least related to which direction the influences worked. It proved hard to reach consensus.
- Even though the experts grasped the fundamentals of the approach, it proved hard for them to keep all variable definitions, value settings, category settings etc. in mind as the discussions went on. The amount of detail soon grew too large.
- The researchers who moderated the discussions had not run MARVEL sessions before.

Because of these effects, part of the model development had to be run after the workshop sessions, just by the research team. This somewhat defeats the purpose of a group oriented process, especially if one of the aims is to establish ownership of the results in the group. However, for complex problems, this may prove to be a necessary approach in the end: Use experts to structure the problem, draw up the causal map and identify the significant loops, and perform post-workshop work to populate the model with data.

The hardest issue with the analysis process was that it was extended over a too long period of time, with breaks of several months between each workshop. The expert group changed somewhat between each session, which made the progress slower. The members of the research

team were also involved in many other activities over the year the analysis lasted. Before each new session, they needed some time to get up to speed on the previous work before progress could be made. In the end, this led to an inefficient analysis process without a solid momentum.

6 Final thoughts

We were unable to reach the goals set for the study. While we managed to test and evaluate the MARVEL tool, we were not able to solve the analysis problem for The Future Land Power project, and we did not provide an answer to the principal research question for the study: How can we analyse the effect of different Norwegian land force contributions in peace and stabilisation operations abroad? We wish to briefly discuss some of the reasons, as a way to summarize the findings of the work.

Is MARVEL the correct tool for such a study? While it is hard to give a clear answer to this based on our attempt at analysing the problem, we observe that one limitation of MARVEL is that it is aimed towards giving first insights into a problem. The results achieved, even by running a finalised model, are likely to be highly uncertain. This means that we would probably not have been able to optimize Norwegian land force contributions in any detail based on the MARVEL approach. At best, we would get indications about which principal choices to make, which could be translated to relevant force packages through a detailed analysis with other tools. MARVEL still seems a good choice for the initial problem structuring, though, and the expert discussions around the causal model were fruitful for getting further insights into the problem.

With the limitations described above, we saw that we would be unable to get the desired answers out of our model, so we terminated the work. While we can't rule out that the chosen problem was too complex for the MARVEL approach, our problems is at least partly due to choices made and errors introduced during the modelling and the not quite optimal analysis process, as discussed in Chapter 5.

The question remains whether it is at all possible to answer the initial research question. One problem is that the goal variable we chose to study, the perceived security of the local population in Faryab, depends on numerous other factors than just the Norwegian forces operating there. Opinions vary on what the relevant measures and the effects of these are, so singling out the (possibly small) contributions from the Norwegian forces to the security situation proved to be too difficult. This, combined with the relatively small range of differences between the possible land force contributions that Norway can muster abroad, leads us to believe that other goal variables could be more relevant, should such an analysis be attempted again.

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Abbreviations

ANNCP	Anglo Netherlands Norwegian Collaboration Project
ANSF	Afghan National Security Forces
CLD	Causal Loop Diagram
COIN	Counter Insurgency
FFI	Forsvarets forskningsinstitutt / Norwegian Defence Research Establishment
ISAF	International Security Assistance Force
MARVEL	Method to Analyse Relations between Variables using Enriched Loops
NATO	North Atlantic Treaty Organization
PRT	Provincial Reconstruction Team
SFD	Stock and Flow Diagram
TNO	Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek / Netherlands Organisation for Applied Scientific Research
UN	United Nations

Appendix A   Experiences with MARVEL

A.1   MARVEL collaboration

One of the objectives of the study was to explore possible applications of MARVEL to modelling of peace and stabilisation operations, including its limitations, possibilities and potential improvements. This activity is part of the Norwegian research program on The Future Land Power (FFI project 1143) and the Dutch research program on Operational Analysis Research Methods for Joint and Combined Land operations (TNO project V940).

Norway and the Netherlands have similar research programmes on operational analysis and (mission) support that pursue different paths of research. On the one hand, TNO has developed a method and a tool in the area of dynamic qualitative modelling, MARVEL, while FFI has pursued other modelling techniques like Cognitive Maps.

Collaboration between the two nations has concentrated on information exchange involving the use of MARVEL, its capabilities and modelling bottlenecks. TNO released a test version of the MARVEL tool to FFI and has provided support on how to use the approach. In exchange, FFI has provided TNO with the results from the modelling on peace and stabilisation operations and its experience with using MARVEL in new areas. FFI has also commented on possible improvements for the MARVEL tool. These evaluations are presented in the following sections.

A.2   Evaluation of MARVEL

Based on our use of the MARVEL tool, we have some findings on possible improvements and suggestions for new functionality.

A.2.1   General usage

We have found that the MARVEL tool is generally good for problem structuring processes, and it provides a useful approach for initial discussions about a problem. The approach also seems generally good for analysis with feedback loops, as long as the problem does not get too complex and messy.

It is possible that it is not suited for a problem of such complexity as the one described in this report. Our first order effects might be too small to detect and too uncertain for optimization. It also proved hard to represent the Norwegian forces as "policy changes" in the model.

Given the general uncertainties about the use of military force in peace and stabilisation operations, validation of the results was always going to be a challenge.

A.2.2   Tool functionality

As for the MARVEL tool itself, we have some comments related to the interface and functionalities provided.

In general, both the MARVEL approach and the tool are somewhat daunting for new users. It would be helpful to have a "MARVEL for dummies" document, or at least an updated, more user-friendly manual. In addition, it would be especially useful to have an overview of all possible menu choices and their impact on the analysis. In the tool itself, we really missed help text and tooltips for buttons, menu items, etc.

During the modelling phase, we saw that we could really have used a notes and description field for the complete model, similar to the fields for the individual variables or arrows. This would be especially useful for documenting the problem formulation and problem structuring as part of the model elements, such as critical analysis choices, clarifications, participants in the modelling, etc. It would also have been helpful to be able to write the values for arrows and variables directly in the table of the arrows/variables without having to use the pop-up menu / dialogue box.

When managing different variables under "manage categories", it would be helpful to have a notes and description field for the different categories. This could be used to write notes, for instance about why we define something as working on the short, medium or long term.

Several times we ran into situations where we deleted variables and arrows from the model, only to find in a later stage that they would be relevant after all. It would have been valuable to be able to copy parts of a model between diagrams or different versions of the model.

During the workshops we ran the model on a big screen for all the participants to see. For this approach, the most important functionality we missed was the possibility to highlight all arrows coming in and out of ONE variable, while hiding all the others. Additionally, it would be helpful if arrows coming into and going out of a variable had different colours when highlighted. It would also be helpful to have different colours for positive and negative arrows, since the plus and minus signs tend to get blurry as the model increases in size.

A few other "nice to have" functionalities for use on a big screen would be:

- Hide all arrows in the model, for a visual study of just the variables.
- Fit the model to the chosen window size (zoom level).
- Change font type and size for variables, in addition to the functionality of colour changes that is already in the model.