FFI-rapport 2013/02307

# Drivers of nuclear weapons proliferation in Egypt and Saudi Arabia

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Norwegian Defence Research Establishment (FFI)

3 October 2013

FFI-rapport 2013/02307

Project 1256

P: ISBN 978-82-464-2312-8
E: ISBN 978-82-464-2313-5

## Keywords

Kjernevåpen

Spredning

Midtøsten

Egypt

Saudi Arabia

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## English summary

Målet for denne rapporten er å redegjøre for drivkreftene bak atomvåpenspredning, og utforske i hvilken grad disse er til stede i Egypt og Saudi Arabia. Dette oppnås ved å utforske to hovedkonsepter; *opportunity* og *willingness*. Opportunity representerer de diverse faktorene som utgjør en stats reelle mulighet til å produsere eller anskaffe atomvåpen; tekniske fasiliteter og ekspertise, økonomisk styrke og motstandsdyktighet og leveringssystemer. Willingness forklares som de utløsende faktorene som leder til avgjørelsen om å anskaffe atomvåpen og er basert på sikkerhetstrusler, innenrikspolitikk, normer og status.

Rapporten finner at Egypt er i besittelse av en vid og avansert kjernefysisk infrastruktur, som potensielt kan benyttes til å produsere like over 8 kg plutonium i året. Til tross for pågående politisk uro i landet har Egypt både en større og mer motstandsdyktig økonomi enn både Pakistan og Nord-Korea, to stater som tidligere har produsert atomvåpen. I tillegg til dette besitter Egypt flere leveringssystemer, fra ballistiske missiler og cruise-missiler til artilleri og et militært luftvåpen. Saudi Arabia mangler per dags dato den tekniske ekspertisen og fasilitetene til å produsere et atomvåpen. Dette kan de derimot gjøre opp for ved å utnytte sin sterke økonomi og økonomiske motstandsdyktighet til å anskaffe ekspertise og fasiliteter, men gjør allikevel at produksjonen av atomvåpen i Saudi Arabia er lite sannsynlig de umiddelbart kommende årene. Man kan derimot stille spørsmål ved Saudi Arabias DF-3 interregionale ballistiske missiler; disse missilene er særdeles lite nøyaktige og har tidligere blitt brukt som plattform for atomvåpenleveranse av det Kinesiske forsvaret. Spekulasjoner rundt et mulig atomvåpensamarbeid med Pakistan, rundt muligheten for å kjøpe kjernefysiske våpen eller materiell, er vanskelig å finne gode bevis for, men bør ikke glemmes i en undersøkelse av landets fare for anskaffelse av atomvåpen.

Denne rapporten konkluderer med at det er mindre sannsynlig for Egypt, men mer sannsynlig for Saudi Arabia, at sikkerhetstrusler kan påvirke statenes stilling til anskaffelse av atomvåpen. Derimot spiller innenrikspolitiske vurderinger en større rolle i Egypt enn i Saudi Arabia ved samme spørsmål. Det er grunnlag for å forvente at begge stater vil bli påvirket av konsiderasjon rundt regional status og prestisje og like fullt hvis det normative regimet rundt ikke-spredning skulle svekkes. Til sist finner rapporten at Egypt har større *opportunity* enn Saudi Arabia til å anskaffe atomvåpen, og at begge statenes *willingness* er avhengig av den fremtidige regionale utviklingen.

## Sammendrag

This report aims to investigate the drivers behind nuclear proliferation and apply an investigation of these to the states of Egypt and Saudi Arabia. It aims to do so by examining two key concepts; opportunity and willingness. Opportunity will be understood as the various factors that comprise necessary conditions for manufacture or acquisition of nuclear weapons. These factors include technological facilities and expertise, economic capacity and resilience, and delivery systems. Willingness will be explained to be the various factors that trigger the decision to manufacture or acquire nuclear weapons. These are based on security threats, domestic politics, norms, and status.

In regards to Egypt, the report finds an extensive and advanced nuclear infrastructure. The currently existing facilities in Egypt could potentially be used to produce plutonium at a rate of just over 8 kg annually. Egypt, despite on-going political turmoil, has a more resilient and stronger economy than both Pakistan and the Democratic Peoples' Republic of Korea, both states that managed to develop nuclear weapons. Ultimately, Egypt fields a variety of delivery systems, from ballistic missiles through cruise missiles, artillery and military aircraft. Saudi Arabia however currently lacks the infrastructure and expertise necessary to manufacture nuclear weapons. This could however be developed, given their big and resilient economy, but makes a Saudi Arabian manufacture of nuclear weapons unlikely in the immediate future. Questions arise however from the Saudi Arabian possession of DF-3 inter-regional ballistic missiles. These missiles are highly inaccurate in pinpoint targeting and tactical use, and have been deployed as delivery systems for nuclear weapons by the People's Liberation Army of China in the past. Speculations that Saudi Arabia has a nuclear cooperation with Pakistan that might allow them to directly purchase nuclear warheads or materials are hard to verify, but important not to discount in an investigation of the state's proliferation risk.

The report finds that Egypt is less likely to seek nuclear weapons as a response to changes in its security situation in the Middle East, while Saudi Arabia is more likely to do so. Domestic politics however are seen as a stronger incentive to acquire nuclear weapons in Egypt, yet plays a less significant role in Saudi Arabia. Both states are likely to be influenced by considerations of regional status and prestige in the event of a nuclear armed Iran, and similarly by a weakening of the normative global regime of non-proliferation. To conclude, the report finds that Egypt has a greater opportunity than Saudi Arabia to acquire nuclear weapons and that the willingness of both states is contingent on regional developments.

# Contents


| | | |
|---|---|---|
| | **Preface** | **7** |
| **1** | **Introduction** | **9** |
| **2** | **Theoretical Foundation: Drivers of Nuclear Weapons Proliferation** | **10** |
| 2.1 | Opportunity | 11 |
| 2.1.1 | Technological and infrastructural capacity | 11 |
| 2.1.2 | Economic capacity | 12 |
| 2.1.3 | Delivery systems | 12 |
| 2.2 | Willingness | 12 |
| 2.2.1 | Security concerns | 13 |
| 2.2.2 | Domestic politics | 13 |
| 2.2.3 | Norms | 14 |
| 2.2.4 | Status | 14 |
| **3** | **Methodology** | **15** |
| **4** | **Choice of Cases** | **16** |
| **5** | **Egypt: Reconsidering Nuclear Decisions?** | **16** |
| 5.1 | Material capacity and opportunity | 16 |
| 5.1.1 | Nuclear Infrastructure | 16 |
| 5.1.2 | Economic dependencies and resilience | 19 |
| 5.1.3 | Egyptian Delivery Systems | 20 |
| 5.2 | Willingness to acquire nuclear weapons. | 20 |
| 5.2.1 | Egyptian security threats and concerns | 20 |
| 5.2.2 | Domestic politics in a divided country | 21 |
| 5.2.3 | Egypt and Non-Proliferation Norms | 21 |
| 5.2.4 | Maintaining the Role as Leader of the Arab World | 22 |
| **6** | **Saudi Arabia: Security Threats and Regional Prestige** | **23** |
| 6.1 | Material Capacity and Opportunity | 23 |
| 6.1.1 | Opportunity: Manufacture or Acquisition? | 23 |
| 6.1.2 | An Economic Powerhouse | 23 |
| 6.1.3 | Saudi Arabia’s Mysterious DF-3 Missiles | 24 |
| 6.2 | Willingness to acquire nuclear weapons. | 25 |
| 6.2.1 | Security Threats; Implications of a Nuclear Iran | 25 |
| 6.2.2 | Domestic Politics: Backstopping Conventional Forces | 26 |
| 6.2.3 | Saudi Arabia and Norms | 26 |

6.2.4 Affirming Role as Regional Power 26

**7 Analysis of findings 27**

**8 Conclusion 28**

**Bibliography 30**

**Appendix A 35**

## Preface

This report represents the work put into my master's dissertation for a Master of Arts degree in International Studies and Diplomacy at the Centre for International Studies and Diplomacy, School of Oriental and African Studies (SOAS), University of London. It would not have been possible without the guidance and feedback, especially on technical issues, of Steinar Høibråten and Elin Enger. I am also thankful to Hege Schultz Heireng and Anders Våge at FFI and Benedicte Brøgger at BI for their thoughtful input and discussions, and to Monica Endregard for facilitating my stay and ability to work with and at FFI for the duration of the writing process.

Kjeller, October 2013
Andreas Gabrielsen

# 1 Introduction

*"If we adopt nuclear technology across our region, it will become a region of mushroom clouds"*
- Ambassador Al-Khalifa of Bahrain to the United Kingdom (Diplomatic Courier, 2013)


*Figure 1.1 Regional Map of the Middle East (Wikimedia Commons, 2013)*

There has been a drive amongst analysts and policy writers to understand the causes and drivers of proliferation as well as understanding which states might be likely to develop nuclear weapons.

This dissertation aims to look at some of the models of explaining drivers of nuclear weapons proliferation, and build on them in order to explain the various factors that give a state an opportunity to proliferate and the factors that make states willing to do so. It will draw from both qualitative and quantitative studies on the drivers of nuclear proliferation, and argue that the opportunity a state has to acquire nuclear weapons must be seen together with the state's willingness to do so. Only when these factors are seen together will it be possible to best understand of proliferation risk a state poses.

Based on this, the dissertation will investigate the risk of nuclear weapons proliferation in two key states in the Middle East; Egypt and Saudi Arabia. Both are notable regional powers, and both are Arab states faced with an assumed Israeli nuclear weapon as well as an increasing possibility of an Iranian nuclear weapon. Other states in the Middle East have attempted to acquire nuclear weapons in the past, but for various reasons, have ended or lost their ability to carry out nuclear proliferation. Furthermore, the actions of these two regional powers will define much of the strategic environment in the Middle East contra the regional security complex involving Israel and Iran. The dissertation will investigate the opportunity and the willingness of these two states to acquire nuclear weapons, before drawing the findings together in an analysis. Having reviewed the findings, the dissertation will present concluding remarks regarding the possibility of future nuclear weapons proliferation in the Middle East.

# 2 Theoretical Foundation: Drivers of Nuclear Weapons Proliferation

In answering the question of whether one should be prepared for a nuclear armed Egypt or Saudi Arabia, it becomes necessary to investigate and understand the drivers of proliferation as well as analysing the extent to which these drivers are present. Several scholars have attempted to explain nuclear proliferation, and amongst these the work of Scott D. Sagan has been instrumental in defining three key models by which analysts may approach the understanding of proliferation. These three models are a security model, a domestic politics model and a norms model. However, Sagan argued that to comprehensively understand the issue and risks of nuclear proliferation, an analyst should not restrict his focus to a single model. As a single model has thus far failed to explain the wide variety of reasons and drivers for states to acquire nuclear weapons, Sagan advocates a multi-causal investigation into a range of drivers of proliferation (Sagan, 1996/1997). This dissertation aims to do so by expanding on Sagan's three suggested models by incorporating in the role of prestige and status.

With this in mind, the argument will be presented in terms of the concepts of opportunity and willingness in order to understand the necessary conditions and causes of nuclear proliferation together with the willingness to do so. This aims to bridge the gap between understanding the technical and economic opportunity to acquire nuclear weapons, combined with the political willingness that would impel a state to proliferate. This qualitative approach entails a range of factors that must be considered together to give a comprehensive picture of proliferation risk, which will be discussed in the following sections.

## 2.1 Opportunity

As not all states willing to proliferate satisfy the necessary conditions for successful manufacture of nuclear weapons, a model explaining the risks of nuclear proliferation necessarily includes a discussion on the opportunity the state has to proliferate. This dissertation will argue that opportunity variables, namely technical and infrastructural capacities and economic resilience, comprise the necessary conditions for a nuclear weapons programme. This view of opportunity stems from a quantitative study on the drivers of proliferation as held by Jo and Gartzke in a 2007 study (Jo & Gartzke, 2007). However, as their argument restricts the understanding of opportunity to technological capacity and availability of fissile materials, this dissertation will expand upon it to bring in economic resilience as an additional factor. Fissile materials and technological ability to produce nuclear weapons rests on the economic capacity and resilience in a state, explaining their inclusion as an opportunity variable. Furthermore, while Jo and Gartzke include delivery systems as a part of technological capacity, this dissertation will discuss them as a separate variable from nuclear technology and infrastructure. This distinction is important as certain delivery systems can be seen as indicators for either a future plan for acquiring nuclear weapons or a hedging strategy in which states would be able to field nuclear weapons in a relatively short time frame upon acquisition.

Including a more technical discussion of capacities and technology is important to understand which states pose a risk of proliferating, as many explanations of nuclear proliferation exclusively focus on the causes of the decision to acquire nuclear weapons fails to explain which states have the opportunity to act upon such desires. As such, an understanding of opportunity makes it possible to narrow the field of states which present a proliferation risk. Understanding this, the subsequent sections will explain the three key factors that comprise a state's opportunity to acquire nuclear weapons.

### 2.1.1 Technological and infrastructural capacity

A complete, domestic nuclear weapons programme necessarily requires a wide range of technological infrastructure and expertise. In order to construct a nuclear weapon, a state needs the ability to either produce plutonium or enrich uranium. The former is possible through the use of nuclear reactors, which generate plutonium as one of several by-products. The generation of optimal weapons-grade plutonium requires specific operating conditions in the reactors. The plutonium is eventually separated from the spent fuels during reprocessing, which is a complex process requiring expensive facilities. Uranium enrichment requires expensive and energy-demanding enrichment facilities. For a completely domestic weapons programme, both types of nuclear weapons material necessitates natural deposits of uranium as well as the capability to mine and process nuclear materials. For plutonium production, it becomes necessary to have at least one operational nuclear reactor, and to use a reprocessing facility to separate the plutonium from the spent fuel. As no state has thus far been able to acquire nuclear weapons through theft or purchase, an investigation into the existence of specific nuclear infrastructure will present an indicator as to whether a state is a risk for nuclear weapons proliferation. However, a brief discussion will be made about the potential for a direct acquisition of nuclear weapons by Saudi Arabia.

### 2.1.2 Economic capacity

While technology, nuclear resources and infrastructure are instrumental to a nuclear weapons programme, they place great demands on a state's economy. Furthermore, a state suspected of producing nuclear weapons often suffer external economic pressures as a result. The Islamic Republic of Iran and the Democratic People's Republic of Korea (DPRK) both suffer widespread economic sanctions for their suspected or proven nuclear weapons programmes. Furthermore, it is evident that weak economic states still have the ability to produce nuclear weapons; Pakistan being a case in point (Nayyar, 1998). Thus, not only does the ability of a state to finance a nuclear weapons programme, but also the capacity to survive its potential economic effects become a crucial part of understanding a state's opportunity to proliferate. The analysis in this dissertation will attempt to give a considered understanding of the implications of going nuclear on the Egyptian and Saudi Arabian economy, as well as its importance as a determinant for nuclear proliferation.

The main way in which this discussion will focus on the economic and financial capacity for nuclear weapons development is to focus on the states' vulnerability and resilience, rather than raw economic strength. As shown, fragile and/or poor states have successfully acquired nuclear weapons in the past, so while arguments are made to the role of financial capacity as a key determinant of proliferation opportunity (Kadhim, 2006), its effects on a state's economy and the subsequent opportunity to develop weapons should be considered secondary to the capacity to resist or survive the detrimental effects a nuclear weapons programme might have on an economy. Resilience has been explained as the "ability of an economy to recover from or adjust to the effects of adverse shocks" (Briguglio et al.2008), and the argument will use indicators of states' resilience as a key means of understanding the financial ability of a state to sustain a nuclear weapons programme.

### 2.1.3 Delivery systems

The final opportunity variable which will be investigated in regards to nuclear weapons proliferation is delivery systems, a concept which encompasses the diverse means of sending or using a nuclear weapon. A state that has developed or acquired through whichever means a nuclear weapon will still need the capacity to deliver the weapon in order for the threat of use or the deterrent effect to be realistic. Thus, simply being in possession of nuclear weapons does not necessarily entail any significant prestige if the means of using them does not exist. This dissertation will investigate the existence of possible delivery systems in Egypt and a discussion about the *raison d'etre* of Saudi Arabia's ballistic missiles.

## 2.2 Willingness

Whereas opportunity in simple terms can be understood as a state's ability to pursue the acquisition of nuclear weapons, the concept of willingness will be understood as the triggers and causes that would cause the decision to act upon the opportunity. As such, we can see that whereas opportunity as presented here is a necessary, but not sufficient, cause for nuclear proliferation, and that it is the combination of willingness factors and opportunity that may lead to

nuclear weapons proliferation. Thus, in order to give an assessment of the proliferation risk of a state, willingness and opportunity must be considered together. There are four key factors of willingness that I will borrow from Jo and Gartzke; security concerns, domestic politics, norms and status (Jo and Gartzke, 2007). Three of these willingness variables correspond with the three models for proliferation espoused by Sagan. These are the security model, the domestic politics model and the norms model, which under his understanding encompasses both norms and status in one model of understanding and predicting proliferation (Sagan, 1996/1997).

### 2.2.1 Security concerns

One of the key models for explaining nuclear weapons proliferation is drawn from realist views on security threats (Sagan, 1996/1997; Mearsheimer, 1990) They argue that an immediate security threat, in this case by an adversary obtaining nuclear weapons, will give significant imperative on the state in question to acquire the same type of weapon. This logic is evident in the case of the nuclear weapons programmes of Pakistan and the DPRK. Although an important consideration and explanatory model, the security explanation alone fails to account for the states with immediate security threats that nonetheless chose not to proliferate, such as Egypt in 1968 when it signed the NPT. Despite the security explanation being the sole necessary component of understanding the willingness to acquire nuclear weapons, this argument will take account of which potential security situations might give either Egypt or Saudi Arabia the necessary impetus to proliferate.

### 2.2.2 Domestic politics

Whereas security concerns often give rise to bold statements by diplomats and leaders, domestic political issues should not be neglected in understanding a state's desire to proliferate. A case in point is the example of the Indian nuclear weapons programme.

Indian Prime Minister Indira Gandhi claimed that the Indian nuclear weapons development was for reasons of the security problem posed by the Chinese bomb, despite this; the development of an Indian nuclear weapon was in large part kept from the military. Even the Indian foreign minister was only informed of the programme 48 hours before the 1974 'Smiling Buddha' nuclear test (Sagan, 1996/1997, p.67). Despite the fact that nuclear weapons decisions are mainly made by a small elite (Rublee, 2006, p.562), the exclusion of much of the armed forces and cabinet figures gives credibility to an argument that other considerations were more important to the development of an Indian nuclear weapon. A better explanation than security threats might be derived from the fact that the detonation of a nuclear weapon caused PM Gandhi's popularity to soar in India, going from popularity at an "all-time low" in 1973/1974 (Sagan, 1996/1997, p.67) to a one-third increase in the month immediately following the detonation (Ibid., p68). The case from Iran also provides evidence of the rallying effect of a national nuclear programme, although arguably for civilian purposes. The programme gathered significant popular support for the regime, while also allowing it to reach a nuclear breakout capability. These cases illustrate the need to understand the various domestic issues that can be seen to motivate nuclear proliferation independent of external security threats.

Thus, in the following analysis, the dissertation will focus on the domestic implications and potential gains that the leaderships of Egypt and Saudi Arabia stand to receive from moving towards either full-blown nuclear proliferation or achieving a breakout capacity.

### 2.2.3 Norms

Simply put, norms share characteristics with what is known as customary international law; the sum of state's practices and *opinio juris*, expert or legal opinion. I will argue that there has been a norm against proliferation, evidenced by the fact that of all the states that explored the idea of nuclear weapons since the P5, only four has acquired them and still maintain an arsenal. One state, South Africa, did develop nuclear weapons, but dismantled them and has since remained against nuclear weapons. Another state, Iran, is currently under international scrutiny for their developments in nuclear infrastructure and uranium enrichment, as it represents a threat to the non-proliferation normative regime, yet maintains its actions are compliant with the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). But norms regulating practice are far from definite guidelines, and while their role in maintaining a state of affairs can seem solid, they are rarely definite.

While the NPT, in effect since 1970, can be argued to have represented the arrival of a stronger international norm against proliferation, this norm is only as strong as the NPT itself, and the norm is facing a challenge on two fronts. The first is that as an integral part of the treaty was the disarmament of nuclear weapons, the states already in possession of nuclear weapons were bound by the treaty to disarm. Despite this, the continued reliance on nuclear weapons in military doctrine, research and development amongst the P5, with their significant conventional military power, raises a question. Namely, if strong states continuously rely on nuclear weapons, there must be an argument for the possession of such weapons for weaker states. Another issue is the fact that if the most powerful states, arguably in the best position to live up to their requirements under the treaty, fail to enforce it, why should the rest of the NPT members feel a stronger incentive to do so?

A second challenge arising from the NPT lies in the right to the development of peaceful nuclear power. Nuclear infrastructure suffers from their inherent dual-use characteristics; a heavy-water nuclear power plant can produce plutonium as a by-product, which with the right reprocessing facilities can be extracted and used for the production of nuclear weapons. Furthermore, enriched uranium can both be used as a fuel for reactors as well as fissile material for bombs, depending on degree of enrichment. And domestically enriching uranium, while a right enshrined under the NPT, and ascertained by both Egyptian and Saudi Arabian diplomats, represents a major concern for the opportunity it affords to produce nuclear weapons.

### 2.2.4 Status

The final trigger or willingness variable for nuclear proliferation that will be discussed is the role of status and prestige as a major or regional power. The basis for inclusion of this view is based on results from the quantitative study by Jo and Gartzke. The study finds that in spite of various findings "status variables, however, do prove consistent determinants of proliferation and that

regional power status increases the likelihood of having nuclear weapons programmes and nuclear weapons" (Jo and Gartzke, 2007). Both Egypt and Saudi Arabia are considered regional powers based upon a measure of a state in a system that has "at least half of the resources of the most powerful state in the system" (Ibid., p.175). What the quantitative study neglects to discuss in any way is the role that contest for perceived status might play in decisions for acquiring nuclear weapons, which will be touched upon in the analysis. Whereas a definition of regional power as discussed is based on simple economic variables, it allows for the possibility of several regional powers, potentially leading to competition between these as to who plays the role of the chief regional power. In this manner, the desire and competition for being not only *a* but *the* regional power might influence states' decisions to acquire nuclear weapons.

# 3 Methodology

In order to understand the risk and probability of proliferation, it becomes necessary to analyse the problem specific to the countries in question in regards to two factors; willingness and opportunity. Whereas willingness spans a range of domestic and international political factors and desires, opportunity is involved in understanding whether such a weapons programme is realistic and technically feasible. This dissertation attempts to move beyond simple political explanations of the problem in order to bring in a solid foundation of technical information and analysis from which to build the analysis of willingness and political issues regarding acquisition of nuclear weaponry. The opportunity, technical experience and expertise, research and infrastructure will be analysed in order to give a comprehensive understanding of the degree to which it is possible for the states of Egypt and Saudi Arabia to pursue nuclear weapons production. To do so, it will look at the history of nuclear research in each country as well as the availability of educated personnel needed in order to pursue such acquisition. Furthermore it will investigate the potential for acquisition or production of fissile materials required to produce nuclear weapons. It is harder to investigate the potential for assembling nuclear weapons provided that fissile materials are available, but this essay will set out in brief the key factors pertinent to do so and explain how.

Having established the relevant technical background for the states and the degree to which pursuing nuclear weapons programmes is viable in the next two decades, the dissertation will set out the relevant security dilemmas, motivations as well as the political drivers and blockers of pursuing such a course of action. It will bring into consideration the degree to which treaty adherence and international law has succeeded and failed in preventing nuclear proliferation and give a critique of the fact that certain treaty adherence, such as the NPT, actually facilitates the dissemination of knowledge necessary to develop a state's nuclear infrastructure, and investigate the extent to whether such aid can serve as a help or a hindrance for a state desiring to proliferate. It will also assess whether there actually exists in fact a norm against non-proliferation.

This dissertation sets out to explain the motivations and conditions for a state to pursue the acquisition of nuclear weapons and the specific case of whether two specific states should be understood as at risk of doing so. It will not investigate the political, diplomatic, strategic and economic *consequences* of the states' potential actions beyond their direct impacts as drivers of

proliferation. Nor will it attempt to suggest best practices for policymaking in counter-proliferation efforts. While an important and interesting aspect of this problem, such focus would distract from the dissertation's analysis. Rather, this work aims to give a wide, multi-causal understanding of the drivers of nuclear weapons proliferation, and hopes that by understanding these causal factors, other analysts or policymakers can formulate the appropriate responses to proliferation threats.

# 4 Choice of Cases

The rationale behind the cases is founded based on the argument from Sagan 1996/1997, arguing that as no single model has thus far been sufficient to explain nuclear proliferation, a multi-causal approach is advocated. However, I will argue that the security/domestic politics and norms models of Sagan only illustrate one side of nuclear proliferation, namely willingness. And at that, they also fail to account for the role of status or prestige might play in a state's decision to acquire nuclear weapons. Furthermore, I will argue that for a discussion on the risks of nuclear weapons proliferation to be relevant, it becomes necessary to move beyond the field of political analysis and international relations and bring in a technical understanding of the state in question's capacity or opportunity to develop nuclear weapons. Only when these factors are considered as a whole will the analyst be able to present a comprehensive understanding of the proliferation risk of a state.

The choice of the states of Egypt and Saudi Arabia for this discussion was influenced by their role as leaders in the Arab world, as well as their role as regional powers. As regional powers, they are in a position to influence norms surrounding proliferation by their choices, and as major Sunni Islamic states, they are likely to experience a security threat by the potential development of an Iranian nuclear weapon. Furthermore, other Middle Eastern states have attempted to produce nuclear weapons in the past; including Syria and Iraq, but given civil war, domestic unrest, and the relative impunity of Israel to strike their facilities they are less relevant to this discussion than Egypt and Saudi Arabia. Egypt currently enjoys a cold peace with Israel, and the United States is a major stakeholder in Israel, Egypt and Saudi Arabia, thus this dissertation will argue that preventive strikes are less likely to occur in these states. Furthermore, the dissertation will show the opportunity of these states to acquire nuclear weapons, which will in retrospect provide further more justification for an investigation into these states.

# 5 Egypt: Reconsidering Nuclear Decisions?

## 5.1 Material capacity and opportunity

### 5.1.1 Nuclear Infrastructure

The discussion of Egypt's risk for nuclear proliferation will open with a discussion of their opportunity and capacity to produce nuclear weapons. The Arab Republic of Egypt maintains and operates an extensive amount of nuclear infrastructure, a heritage from their investigations into

developing a nuclear weapon in the 1960s. It has been claimed that besides Israel and Iran, Egypt has one of the most advanced nuclear programmes in the region (Fitzpatrick, 2011). The main facilities of the Egyptian nuclear infrastructure include two research reactors, reprocessing facilities, fuel production plants, a minor enrichment capacity. Egypt also several uranium deposits on its territory. Further nuclear infrastructure includes storage facilities, cyclotrons and research facilities, but these facilities will not be discussed at length as they are not vital to the production of nuclear weapons and as such are of secondary importance to this discussion.

Egypt performs a variety of nuclear research at two research reactors, both located in the Inshas suburb of Cairo. The first, ETRR-1 was constructed with aid from the Soviet Union and was operational from 1962. It has a nominal thermic effect of 2 $MW_t$ (IAEA, 2013). The second, ETRR-2, built with the assistance of the Argentine company INVAP, has been operational since 1997 and has an effect of 22 $MW_t$ (IAEA, 2013). Both are light-water reactors (that is, using regular water, $H_2O$), which are considered less of a proliferation risk than heavy-water (deuterium, or $D_2O$) reactors due to a decreased output of weapons-grade plutonium (FAS, 2000). For a light-water reactor, the core would have to be moderated with graphite in order to efficiently produce Pu-239, the isotope of plutonium used in nuclear weapons. However, a similar outcome could also be achieved by withdrawing fuel rods for reprocessing after a short time in the reactor. The Egyptian reactors are not graphite moderated, and IAEA supervision would imply that an increase in turnover of reactor fuels would be detected. Nonetheless, the Egyptian research reactors have a minor capacity to produce weapons-grade plutonium. As a rule of thumb, a 1 $MW_t$ of power for one day produces 1 g of weapons-grade plutonium (Ibid.). Thus, assuming peak conditions and constant operation, the Egyptian research reactors could be capable of producing just over 8 kg of plutonium annually. A typical nuclear weapon design is generally assumed to require as little as 4-5 kg of plutonium, and thus, using only the two research reactors, Egypt has a maximum potential capacity to produce sufficient plutonium for two nuclear weapons per year (Ibid.). A more realistic view is that of the Wisconsin Centre which holds that from the ETRR-2 reactor, Egypt is capable of producing sufficient plutonium for one weapon annually (Wisconsin Project, 1996).

Aside from the two research reactors, Egypt also maintains extensive infrastructure related to a nuclear fuel cycle necessary to maintain an indigenous nuclear power production, and, potentially a nuclear weapons development capability. The front end of such a cycle revolves around the production and enrichment of fissile fuels. Egypt maintains the facilities necessary for mining and processing uranium ore and uranium fuel fabrication. The IAEA confirms two uranium deposits in Egypt; Abu Tartur and Gamal Gutter. The Nuclear Materials Authority of Egypt further claims the existence of seven other uranium deposits, without specifying the quantities in question (AbdulRazek, 2009) Egypt has the potential to extract this ore by means of the Semi-Pilot Extraction Plant located at Inshas, and placed under IAEA supervision. The plant however has experienced a range of problems (NTI, 2013). As Egypt has the capacity to mine and extract uranium domestically, an effort by the international community to limit the amount of fissile fuels for purchase would not be an efficient counter-proliferation strategy. The final part of Egypt's

front-end of the nuclear fuel cycle involves its two fuel production plants, both under IAEA supervision, responsible for production of fuel elements for the Egyptian Research Reactors.

The back end of a nuclear fuel cycle involves storage of spent fuels as well as spent fuel reprocessing, the act of separating plutonium and uranium from the rest of the spent fuel. Egypt maintains two reprocessing facilities. The first of these can be found in the Hydrometallurgy Pilot Plant located at Inshas, which works on separating uranium and plutonium from spent fuels (NTI, 2013). Egypt was reprimanded and cited by the IAEA in 2005 for not declaring this plant (Fitzpatrick, 2008, p.24). The act of developing or operating nuclear facilities outside IAEA supervision draws similarities to the act of hiding nuclear infrastructure from the IAEA, such as in the case of Iran, and can raise doubts as to the future nuclear intentions. The Hot Laboratory and Waste Management Centre also located at Inshas, was established in 1980 and completely operational in 2000. It is involved in nuclear waste management and vitrification, the process in which nuclear waste is encapsulated in glass for long-term storage, and has capacity for plutonium extraction research (NTI, 2013).

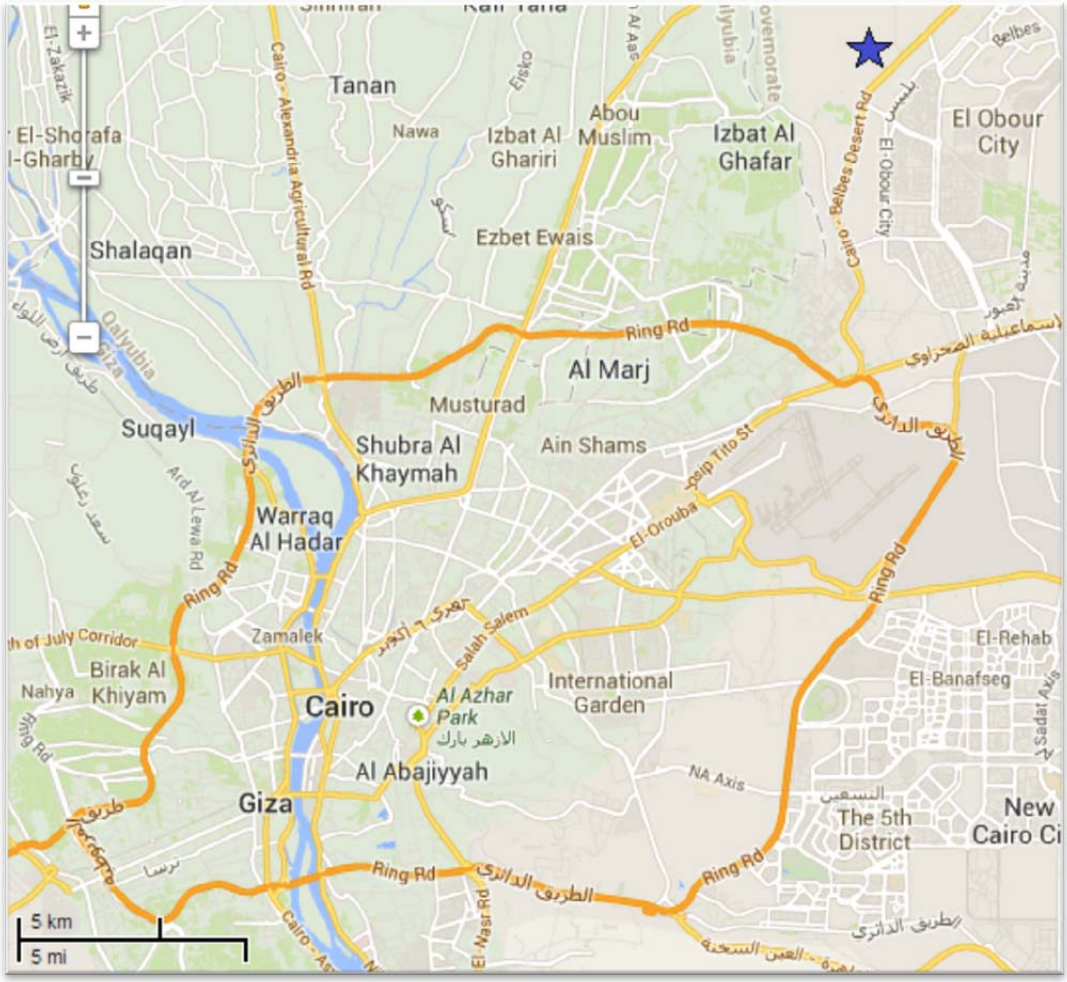


*Figure 5.1 Location of Egyptian Research Reactors, Hydrometallurgy Pilot Plant and Hot Laboratory Waste Management Centre. (© Google Maps 2013)*

From these findings, it becomes apparent that Egypt has the potential to domestically mine, refine and process uranium fuels. Furthermore, Egypt has the ability to produce plutonium from the two research reactors at potential rate of just over 8 kg a year. When combined with the ability to extract plutonium from spent fuels, it is clear that production of plutonium at a small scale cannot be ruled out in Egypt. However, the infrastructure faces challenges to this in form of the state of the facilities, with several facilities not operating at capacity, facing challenges or lacking the necessary finances in order to operate at peak conditions (NTI, 2013). Mark Fitzpatrick stated in 2011 that Egypt is still far from having a functioning, complete and indigenous fuel cycle necessary for a nuclear weapons programme (Fitzpatrick, 2011). Other scholars however argue that with concerted effort, Egypt is realistically no more than five years away from an ability to provide fissile materials for weapons (Einhorn, 2006). Considering the long history and wide range of nuclear research in Egypt, coupled with the lessons learnt from their current facilities it would appear that, given sufficient political and financial investment, a future complete fuel cycle and nuclear weapons programme is far from impossible.

### 5.1.2 Economic dependencies and resilience

A key issue for an Egyptian nuclear weapons programme lies in the state's economic capacity for such an undertaking. While estimating directly the cost of such a programme would mean an investigation of such depth and amount of variables as to warrant a full dissertation in its own rights, this dissertation will rather look in larger terms at the vulnerability and economic strengths of Egypt in order to gain a rough image of whether it has the capacity to develop such a weapon. Kadhim makes the argument that adequate financial resources is one of the three components of a successful nuclear programme, alongside scientific expertise, which Egypt is proven to enjoy, and sustained political resolve, which will be discussed in a subsequent section. In the case of financial resources he makes the argument that despite their scientific expertise and infrastructure, "Egypt's financial weakness will continue to be a significant impediment to its success" (Kadhim, 2006, p.587). Yet less economically developed states have succeeded in developing nuclear weapons in the past, examples being Pakistan and the DPRK, thus a key indicator for which to base the assessment of Egypt's financial ability to sustain a nuclear weapons programme in the face of economic sanctions or by diverting significant amounts of government spending is the resilience of the economy, rather than more basic metrics of economic strength. Furthermore, the Egyptian armed forces' control of between 10-40% of the economy makes it easier to allocate resources for a nuclear weapons project (Al Jazeera, 2013).

Data from Briguglio et al. place Egypt's resilience index at 0.412, compared to the Islamic Republic of Iran at 0.445 and Pakistan at 0.291 (Briguglio et al. 2008). Two points become clear from this data. Firstly, that Pakistan, a significantly less economically resilient state, still managed to acquire nuclear weapons; and secondly that the state of Iran, not significantly more resilient than Egypt, manages to survive repeated rounds of economic sanctions without significantly hindering its uranium enrichment and nuclear development (Katzman, 2013). Thus, Egypt would likely be able to survive the impacts related to a nuclear weapons programme. A more pressing economic question would then be whether the state is willing to foot the development and operational costs of nuclear weapons.

But for a more qualitative understanding of the risk of proliferation in Egypt, the domestic political effects will probably give a better understanding of the likelihood of an Egyptian nuclear weapons programme.

### 5.1.3 Egyptian Delivery Systems

Egypt fields a wide range of weapon systems, ranging from planes, through cruise missiles and artillery to medium-range ballistic missiles, and a history of attempting to develop indigenous ballistic missiles (NTI, 2013). Their ballistic missile arsenal mainly consists of roughly 100 Scud-B missiles with a range of 300 km and a payload of 985 kg. They are also rumoured to be have developed around 90 Project T missiles with the assistance of the DPRK (Ibid.); a variant on the Scud-B missile with an extended range of 450 km for a similar payload weight. Beyond the Scud-B and its variations, there are also reports and allegations by US and Israeli intelligence sources of an attempt to develop a missile based on the Scud-C with the aid of the DPRK with a range of 550km and a payload of 500 kg (Ibid.).

In addition to ballistic missiles, the Egyptian armed forces also field a wide range of cruise missiles (NTI, 2013). Notably, these are mainly Land-to-Sea missiles with naval targets in mind, and as such are unlikely to be a prime candidate as a nuclear weapons delivery system. Furthermore, the Egyptian armed forces field ground artillery, notably 721 FROG-7 rockets from 12 launchers with a range of 70 km and a payload of 450 kg. These FROG-7 rockets were a result of Soviet research and development into nuclear weapons delivered by artillery, and was fielded to that purpose by the USSR armed forces (Ibid.). Beyond artillery and missile capabilities, the Egyptian air force maintains a fleet of roughly over 200 F-16 fighter planes. Despite the current political turmoil, Egypt is receiving new ones regularly from the United States as military aid (Ibid.). The Egyptian air force also fields roughly 77 Mirage jets of types Mirage 2000 and Mirage-5 (Ibid.). Pakistan has based its airborne delivery of nuclear weapons on F-16 and Mirage jets (US National Security Council, 2000), and thus Egypt could base a delivery system on their existent planes.

## 5.2 Willingness to acquire nuclear weapons.

### 5.2.1 Egyptian security threats and concerns

The Egyptian choice not to pursue nuclear weapons upon the assumed arrival of a new, significant security threat in an assumed nuclear armed Israel evidences the failures of the security model of proliferation to explain nuclear proliferation in all instances (Sagan, 1996/1997). As the assumed Israeli nuclear weapons programme did not suffice to spur Egypt towards acquisition of a nuclear weapon, it is contentious whether the arrival of a nuclear armed Iran would do so. Arguably, the fact that Israel elected to remain opaque about the existence of a nuclear arsenal served to allow the choice to remain non-nuclear for several Arab states. A clear stance from Israel that they are in fact in possession of nuclear weapons might be sufficient to force Egypt to reconsider its non-nuclear stance. As to the question of Iran, Egyptian Ambassador to the IAEA Abdel Aziz stated that a nuclear Iran represents a security threat to the entire Arab World (NTI, 2013).

Despite the fact that an Iranian bomb might represent less of a significant security threat to the state of Egypt, it is conceivable that security concerns might be used as a justification for a nuclear weapons programme in Egypt.

A secondary issue to consider in regards to the Egyptian security position given a nuclear weapons programme would be their relationship with allied states. Egypt does not fall under any nuclear umbrella (ILPI, 2012), yet their security situation has been reliant on US arms and training. A domestic nuclear weapons programme might shift the scales to such a significant extent that they would not be able to rely on receiving further materiel in the face of a potential security threat. Ultimately, Egypt does not face any immediate increases in security concerns that have been traditionally linked to an opponent's acquisition of nuclear weapons, and as such, it should be understood that while security concerns could be used as a justification, it is more likely that other factors play in in regards to the initiation of an Egyptian nuclear weapons programme.

### 5.2.2 Domestic politics in a divided country

Beyond external security threats, the domestic political situation in Egypt give cause for concern about potential nuclear proliferation. Egypt has in the last two years seen a revolution leading to the end of the regime of Hosni Mubarak, and subsequently saw their first democratically elected president, Mohamed Morsi, attempt to change the constitution to his party's advantage and be ousted in what has been described variously as a coup and as 'safeguarding democracy'. Regardless of whether one prefers Mubarak, Morsi or any other alternative, two things are clear from the domestic situation; firstly, the population is being increasingly divided about the political elites, and secondly, the armed forces of Egypt are one of the most stable power bases in the state. As previously established, other regimes have gained significant, wide-spread domestic support for their national projects from domestic uranium enrichment in Iran to nuclear weapons testing in India.

Being faced with a potential, however significant or not, security threat by Iran and the changing security situations in the Middle East, the political elites of Egypt might see pursuing either a break-out capacity or actual nuclear weapons as an expedite means of uniting a divided population behind the regime. The effect that nuclear infrastructure and weapons has had on uniting divided populations combined with the changing security situations in the Middle East might present too tempting an opportunity for the Egyptian political elite to pass up on in order to gain the leverage afforded by nuclear weapons, finding common ground amongst the population as well as justifying it against an external enemy. Thus, domestic political considerations appear more significant in understanding Egypt's willingness to pursue nuclear weapons than security motivations do alone.

### 5.2.3 Egypt and Non-Proliferation Norms

Egypt distanced itself from acquiring nuclear weapons in the face of an adversary's nuclear weapons programme in favour of attempting to leverage a nuclear weapons free zone (NWFZ) in the Middle East, and in order to gain status. Since that decision, Egypt has advocated the

non-proliferation norm and the creation of such a zone, presumably in order to reduce the leverage that the assumed Israeli nuclear weapons have on Egypt. However, Egyptians have made it clear that if such a zone was to be considered impossible, it might reconsider its stance on non-proliferation (NTI, 2013). If an Iranian nuclear weapon leads to the abandonment of Egypt's non-nuclear stance, it presents a double threat in the form of both an increasingly complex security situation in the Middle East, combined with a global weakening of the norm against proliferation. Despite the security threat of an assumed nuclear-armed, adversarial neighbour, Egypt elected not to pursue the acquisition of nuclear weapons. This has been explained by the fact that the Egyptian leadership saw greater gains by joining the NPT in order "to embarrass his enemy, to enhance his nation's credibility and to further Egypt's leadership in the Arab world" (Rublee, 2006 p.563). However, Rublee highlights the fact that "a country may rethink its decision to stay non-nuclear if one of its regional rivals begins work on a nuclear weapons programme" (Ibid p.560). This didn't happen in the case of the open secret of a nuclear armed Israel, but the question now is whether this will still hold true for a nuclear-armed Iran? Whether Egypt stands to gain more by remaining non-nuclear will be a crucial determinant as to whether it will act upon its opportunity for nuclear proliferation.

### 5.2.4 Maintaining the Role as Leader of the Arab World

A final, but important consideration in understanding the Egyptian state's willingness to proliferate will be the role that prestige and status plays in regards to nuclear weapons. Russell argues that "Cairo is likely to view Iran's nuclear weapons as another blow to the Egyptian worldview as the leader in the Arab and Islamic worlds" (Russell, 2005, p.38). Traditionally, Egypt has portrayed itself and acted as exactly such a leader, yet the prestige associated with nuclear weapons could tip the scales towards Iran and as such, when considered with the other incentives Egypt has to proliferate, lead to an Egyptian bomb as well. Furthermore, given the political situation and unrest in the 2010's, a project on such a grand scale would return much of the prestige lost due to internal conflict, revolution and counter-revolution. Another consideration would be if Saudi Arabia was to acquire nuclear weapons as a response to an Iranian acquisition. Were this to happen, Egypt's role as leader of the Arab and Islamic world would take a further blow, potentially increasing the pressure on the Egyptian regime to follow suit in order to maintain an external sense of power and status in the region.

Having considered these four factors, we find that while the security situation in Egypt and possibly arising from nuclear armed neighbours would not be likely to warrant nuclear proliferation. Yet, there are several other considerations interplaying and reinforcing each other to such an extent that a future choice to acquire nuclear weapons could seem likely. These factors however are contingent on whether Iran was to acquire nuclear weapons, as well as other regional actors' responses to such an act. If the normative regime surrounding nuclear weapons is weakened in the Middle East, and Egypt sees its status as a regional power threatened, the temptation to gain national cohesion and portray itself as a regional power might become too much to pass up on for the state of Egypt.

# 6 Saudi Arabia: Security Threats and Regional Prestige

## 6.1 Material Capacity and Opportunity

### 6.1.1 Opportunity: Manufacture or Acquisition?

Unlike Egypt, Saudi Arabia currently has very little nuclear research or infrastructure. Whereas the Egyptian experience with nuclear research and wide range of facilities would make any decision to develop nuclear weapons possible, the Saudis would have to begin from scratch. As of February 2013, the Nuclear Threat Initiative maintains that Saudi Arabia has no uranium deposits and no mining (NTI, 2013). These findings are challenged by the IAEA UDEPO, or Uranium Deposit, database that lists three separate uranium deposits in the state; Al Jalameed, Ghurayyah and Jabel Sayid (IAEA, 2013). Only the Ghurayyah deposit, estimated to contain 25,000-50,000 tons of uranium ore at a concentration of 0.01-0.05% uranium is being explored for mining (Ibid.). The deposit at Al Jalameed is estimated to contain similar yields, while the Jabel Sayid only contains 2,500-5,000 tons of ore at the same concentration. Despite the current lack of research and nuclear technology in Saudi Arabia, there are plans to spend $300 billion to construct 16 nuclear power reactors, with the first set to be operational in 2021 (Fitzpatrick, 2011).

Besides manufacture, a consideration is the potential for a Saudi purchase of Pakistani nuclear infrastructure, technology or even a nuclear weapon. A Saudi Arabian defector to the US, Khilewi, claimed that Saudi Arabia in great part financed the Pakistani nuclear weapon programme (NTI, 2013). The potential existence of a nuclear relationship or debt must be taken into account when considering the opportunity for Saudi Arabia to develop nuclear weapons. Whether Pakistan would allow a change in paradigm by selling a nuclear warhead directly is unlikely; it is exactly the kind of black swan event in which an unforeseen act completely changes the game. And even if such a transaction did not occur, Pakistan might simply supply designs or actual facilities for enrichment of uranium should Saudi Arabia decide to call in their favours. And for a Pakistan faced with the potential security threat of a nuclear armed Shi'a neighbour, it may be seen as a valuable strategic calculation to counterbalance the new threat by not being the sole Sunni nuclear power, nestled in between India and Iran. Speculations over the nuclear relationship between Saudi Arabia and Pakistan arise regularly upon the incidence of visits between Saudi or Pakistani defence officials. However, while there is much speculation as to the extent of a nuclear cooperation or deal between the two, they remain publicly unconfirmed to this date (Salama, 2006). Thus, when Saudi ambassadors proclaim their ability to be nuclear armed within weeks of Iran publicly acknowledging possession of nuclear weapons, these statements should be taken with a grain of salt.

### 6.1.2 An Economic Powerhouse

Where Saudi Arabia is lacking in the technical expertise and experience with nuclear infrastructure, it does to a larger part have the financial capacity for the development of nuclear weapons (Kadhim, 2006). Unlike Egypt, the Saudi Arabian economy is far less dependent on foreign aid, if at all. World Bank Data shows that over the past two decades, Saudi Arabia has at

most received just under $ 50 million in 1992 (World Bank Data, 2013). More telling, is the fact that the same data points to instances of receiving negative net aid, down to $ -131 million in 2007 (Ibid.). A case of negative aid being recorded simply illustrates that Saudi Arabia is a more significant aid donor than it is a receiver. This again provides evidence to the self-reliance of the Saudi Arabian economy, assuming continued trade in petroleum.

The US Energy Information Administration (EIA) highlights how the Saudi Arabian economy is dependent on petroleum exports, with such exports accounting for 90% of its total export revenues (EIA, 2013). 15% of this petroleum goes to the United States, with another 15% to Europe and 54% to Far East Asia (Ibid.). Given the current global demand for petroleum, it appears unlikely that any sanctioning of Saudi Arabia's chief export would occur, due to the dependency of global powers on Saudi petroleum. This places Saudi Arabia in the position of standing to increase theirs export revenue by a greater reliance on the planned nuclear power. However, from the dual-use nature of much nuclear infrastructure, Saudi Arabia could potentially also reap the rewards of the technology and means of producing fissile materials for nuclear weapons.

### 6.1.3 Saudi Arabia's Mysterious DF-3 Missiles

A big question mark in the case of Saudi Arabia as a potential proliferation risk lies in their arsenal of DF-3 Inter-Regional Ballistic Missiles purchased from China towards the end of the 1980s (NTI, 2013). Estimates of the number of missiles vary, but generally range from the roughly 50 proposed by the Nuclear Threat Initiative (Ibid.), to 120 operational missiles reported in the defence publication Flight International in 1990, citing Israeli intelligence sources (Flight International, 1990). Jane's Defence estimated the missiles' range to be a potential 3,500-4,000 km with a Circular Error Probable (CEP) of 1-4 km. The CEP is a measure of precision wherein a missile with a CEP of 4 km has a 50% chance of landing within 4 km of its target. The fact that Saudi Arabia maintains an arsenal of weapons with such a low precision begs a question about their intended use, as a missile with a CEP of 1-4 km would be far from effective in counter-force strikes. Further cause for attention is the fact that similar DF-3 missiles were armed with nuclear warheads by the Chinese People's Liberation Army (Missile Threat Project, 2012). Sean O'Connor writing for Jane's Defence stated that "Saudi Arabia essentially procured a weapon system whose characteristics seemingly preclude it from being used with conventional warheads." (IHS, 2013). Furthermore, O'Connor investigated a recently discovered missile base in Saudi Arabia, with most of the infrastructure based underground. The facility, located at Al Watah, has two concrete launch pads, one aimed towards Tel Aviv, and the other Tehran (Ibid.).

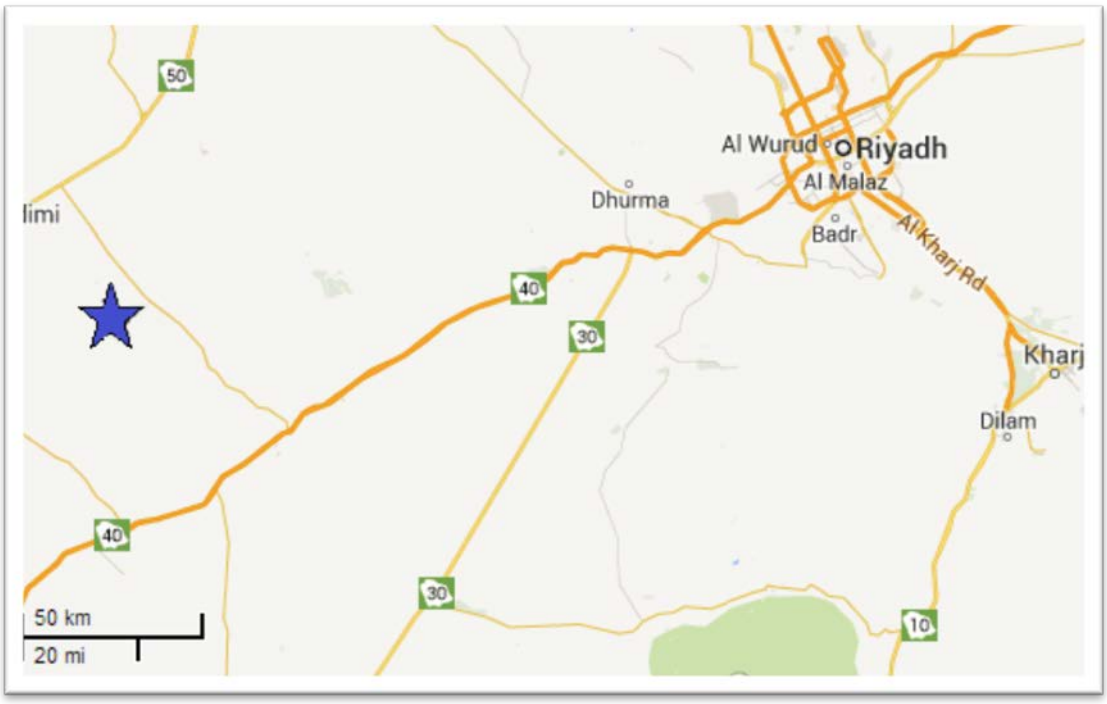


*Figure 6.1 Map of Saudi Arabian DF-3 Missile Base at Al Watah (© Google Maps, 2013)*

Whereas Saudi Arabia would have a long way to go in order to develop a nuclear weapon, they appear able to deliver them in short order upon acquisition, bringing to mind the speculations and discussions about the potential to directly acquire nuclear weapons from Pakistan. Furthermore, the state has established missile systems that, without nuclear weapons, lack suitable justification for their investments and thereby constitute a wild card in the uncertainty about the nuclear cooperation with Pakistan. Unless the unlikely scenario of a direct nuclear transaction was to occur, the main obstacle to a Saudi Arabian nuclear weapons programme lies in the state's lack of technical expertise and nuclear infrastructure. Whether this will change with the planned construction of nuclear power reactors will become apparent over time.

## 6.2 Willingness to acquire nuclear weapons.

### 6.2.1 Security Threats; Implications of a Nuclear Iran

Unlike Egypt, Saudi Arabia faces more significant potential security threats. While the current security situation in the Gulf has not led to a drive to acquire nuclear weapons, the possible advent of an Iranian nuclear weapon would change the geopolitical and security landscape significantly for the Gulf States (Russell, 2005). Possession of nuclear weapons would allow the Shi'a Iranian regime greater leverage in political questions, and Shi'a expansionism in the Arab Gulf remains a real source of concern for Saudi Arabia (Ibid). Based on the evidence highlighted before, the arrival of a new, significant security threat does not necessarily induce a willingness to acquire nuclear weapons, as in the case of Egypt faced with assumed weapons in Israel in the 1960s, yet it has also been shown to be a sufficient condition for nuclear weapons proliferation in the past, in the cases of Pakistan and the DPRK.

An interesting consideration however would be the extent to which a nuclear armed Iran might lead to Saudi Arabia and Israel finding themselves as unlikely bedfellows. Both states are enjoying a tenuous cold peace and see each other as a security concern in the Middle East. However, the expansionist Shi'a regime of Iran represents a security threat to both Israel and the Arab states. This in turn could lead to a case where Israel and Arab states might find themselves facing a mutual enemy. Thus, ironically, the potential arrival of a new security threat to Saudi Arabia may serve to reduce tensions with Israel. Despite this, Saudi Arabia is rapidly finding itself in a region of actors fielding conventionally strong armed forces and potentially nuclear weapons. This is a fact that likely will be taken seriously by the house of Saud, and influence its political decision-making in the coming years.

### 6.2.2 Domestic Politics: Backstopping Conventional Forces

Similarly to the security situation, the domestic political situation in Saudi Arabia is also the inverse of the one in Egypt. Saudi Arabia enjoys a relative amount of political stability under its regime (CSIS, 2011). A factor in this equation however might be the shortcomings of the Saudi Armed forces. While resource-rich, the Saudi Armed forces suffer from both shortages in personnel and in training which becomes more evident when compared to the Israeli Defence Force or Iran's Revolutionary Guard. The Global Fire Power maintains a 'Power Index' of states conventional strengths, based on a variety of indicators including personnel, technology and capacity amongst others, with an ideal score being at 0.0000 (GFP, 2013). In this ranking, Saudi Arabia at 1.1038 comes far short of its strongest conventional opponents of Israel, at 0.7559 and Iran, at 0.7794 (Ibid). Furthermore, it has a significantly smaller population less than half of the population of Iran. While Saudi Arabia might benefit from the security co-operation amongst the Gulf States, it might be seen as a temptation to backstop such conventional failures by acquiring nuclear weapons to balance out their key adversaries.

### 6.2.3 Saudi Arabia and Norms

In the question of norms adherence, Saudi Arabia is an NPT member who has long been arguing for the creation of a NWFZ in the Middle East. However, high-ranking Saudi officials have also been clear on the regime's position, similar to Egypt, that if such a zone is deemed impossible, they will seek nuclear weapons of their own (Burke, 2011). These statements could justify fears of a nuclear "domino effect" contingent on a nuclear armed Iran serving to weaken the norm against proliferation. It is not clear however whether nuclear proliferation in the Middle East would weaken the norm against proliferation, or whether the norms would be weakened as a result. Either way, this issue further highlights the role Iran plays in the security and proliferation decision-making in the Middle East.

### 6.2.4 Affirming Role as Regional Power

Having already explained the role status and prestige plays as a motivation for the acquisition of nuclear weapons, it becomes clear that Saudi Arabia shares this drive with Egypt. While Egypt has been traditionally considered the leader of the Arab world, Saudi Arabia also faces competition to be seen as a regional power. Both Egypt and Saudi Arabia were classified as regional powers by Jo and Gartzke's quantitative work on proliferation, and it was shown that

there was a statistically significant increase in the likelihood of proliferation when this criterion was satisfied (Jo and Gartzke, 2007). Furthermore, whereas Egypt is in larger part dependent on aid and development assistance, Saudi Arabia has a greater degree of autonomy in the international sphere.

# 7 Analysis of findings

Looking at the evidence presented, it becomes apparent that Egypt and Saudi Arabia each face different challenges and would have different incentives for acquiring nuclear weapons. Egypt's long history and high degree of sophistication in nuclear technology and research makes it well equipped for developing a nuclear weapons programme. The biggest obstacle to opportunity is its economic weakness. However, whereas scholars have argued that such economic weakness is sufficient to preclude a potential weapons programme (Kadhim, 2006), it is a fact that weaker and more vulnerable economies have produced nuclear weapons in the past shows that the argument from economy that Egypt lacks the opportunity to produce nuclear weapons is weak. In addition to these factors, it is evident that if Egypt was in possession of or managed to develop a nuclear weapon, it would have the means to use it.

In terms of willingness, the picture from Egypt is less clear, although this dissertation will make the argument that there are several incentives for the development of a nuclear weapon. Despite having elected not to follow suit upon Israel's opaque nuclear weapons programme and being less directly threatened by a nuclear Iran, the changing security situation in the Middle East might encourage Egypt to acquire nuclear weapons. The political situation in Egypt is uncertain and this dissertation has not made it an aim to predict the direction which it might take, but allows for the potential use of an expanded nuclear infrastructure or even a nuclear weapons programme in order to garner popular support behind the regime. The changing security situation and Iran's move towards a breakout capacity combined with the neglect of the established nuclear weapons states to disarm can be seen as a weakening of the norm against proliferation, and Egyptian spokesmen have been clear that if their aim of a nuclear weapons free zone in the Middle East fails, they may reconsider their choice of non-proliferation. One of the strongest incentives for an Egyptian nuclear weapon may be the desire for prestige in the region; the challenges posed by the recent nuclear developments in Iran, this could lead to a desire to acquire nuclear weapons as an affirmation of their role as a traditional leader of the Arab world. Whether these various incentives will combine to make Egypt reconsider its non-proliferation stance and make use of their opportunity to produce nuclear weapons is contingent on regional factors are beyond the scope of this dissertation. What is clear is that if the political will for a nuclear weapon should become present, Egypt would be in a strong position to carry out its development.

The case of Saudi Arabia is in some ways the inverse of Egypt, and in other ways remarkably similar. Whereas Egypt has a long history of technical expertise, Saudi Arabia has very little in terms of nuclear infrastructure, and despite plans for nuclear power plants in the future have no means of rapidly developing a weapon or a breakout capacity. Despite this lack of technical expertise and infrastructure, Saudi Arabia stands in a much stronger economic position to see

through such developments were the necessary political decisions made. Intriguingly, the existence of a Saudi Arabian long-range missile capability raises questions as to the future stance on Saudi Arabian proliferation, and their existence highlights a potential hedging strategy by the regime should they one day desire nuclear weapons. The wild card in the Saudi equation is the extent of their nuclear relationship with Pakistan. In the unexpected event of a direct purchase of a limited number of nuclear warheads, Saudi Arabia would be an economically resilient nuclear weapons state with a long reach.

Whether the Saudi state should desire this outcome is, like in the case of Egypt, contingent on regional developments, but the security threat posed by a potential nuclear armed Iran is much more severe than in the case of Egypt. Furthermore, it is possible that this might alleviate some tensions between Saudi Arabia and Israel, but more likely it will give rise to an even more complex security situation in the Middle East, with an increasing number of nuclear capable states. In terms of domestic politics, Saudi Arabia does not face the same challenges as Egypt does and may not potentially stand to gain as much as Egypt if it were to acquire nuclear weapons. However, again like Egypt, Saudi Arabia has made clear statements as to its nuclear intentions in the face of a weakening of the non-proliferation norm, albeit in a significantly more direct manner. The extent to which this is political rhetoric can be debated, but it remains an important consideration in attempting to evaluate a state's risk of proliferating. Finally, Saudi Arabia would have much of the similar drive as Egypt for the prestige and status afforded by nuclear weapons, although this like several other factors is contingent on a change in the current nuclear status quo in the region.

# 8 Conclusion

In the continuously developing security situation in the Middle East, due attention should be given to more states than those already proven to be in the process of acquiring a break-out capacity or actual nuclear weapons. This dissertation has presented an unorthodox multi-causal method for understanding drivers of nuclear weapons proliferation. The main strength of such an approach lies in the ability to analyse and explain which states have the opportunity; through technical and economic means, and the willingness; influenced by strategic and political factors, to acquire nuclear weapons.

The findings of this dissertation show evidence that Egypt could be capable of producing a very limited amount of nuclear weapons given their current infrastructure, but has an economy that should be resilient enough to withstand the worst effects of such a policy. Furthermore, Egypt would be able to put such weapons to use, or at least enjoy a credible deterrence effect upon acquisition of a nuclear weapon. Saudi Arabia lacks the technology and infrastructure present in Egypt, but does have substantial economic resources and resilience if the decision was made to acquire nuclear weapons. And a question remains as to the intended use of the Saudi Arabian DF-3 missiles. The difference then between the two states is that in the case of Saudi Arabia, proliferation would either happen instantaneously, based on a potential purchase from Pakistan, or very slowly, if the state has to develop nuclear weapons domestically.

Having shown evidence that both Egypt and Saudi Arabia have the opportunity, to a greater or lesser extent, of acquiring nuclear weapons, the discussion moved towards the extent to which the states could be found willing to acquire such weapons. Egypt would be less likely to respond to the change in its security situation posed by a potentially nuclear Iran, but developing a nuclear weapon in order to gain domestic support appears viable given the current conditions in the state. Saudi Arabia however, does not have the same need to gather support for the regime. Rather, it experiences a more significant security threat from Iran and its potential nuclear weapons. Both states share a similar stance in terms of the normative regime regulating nuclear proliferation, and as such these states warrant attention if the norms surrounding nuclear proliferation were to weaken. Similarly, both states could be motivated to acquire nuclear weapons through a regional contest for status and prestige, yet whether this will manifest itself in the proliferation of nuclear weapons is difficult to ascertain.

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# Appendix A

| Facility Type | Facilities | Capabilities |
|---|---|---|
| Research Reactors | ETRR-1; ETRR-2 | ETRR-2 uses fuel from FMPP. Spent fuel is managed at NCB, HMPP, and HCL and could produce roughly 8 kg of plutonium annually. |
| Nuclear Conversion | Nuclear Chemistry Building (NCB) | NCB has experience with irradiating fuel cells from FMPP, and dissolving them in laboratories. |
| Waste Management | Hydrometallurgy Pilot Plant (HMPP); Hot Cell Laboratories (HCL) | Potential for research on plutonium extraction from spent nuclear fuel. |
| Fuel Fabrication | Fuel Manufacture Pilot Plant (FMPP); Nuclear Fuel Research Laboratory | Able to shape and form LEU uranium solids from UF6 gas. |
| Nuclear Research and Development | Van de Graff Accelerator; Inshas Cyclotrone Facility; Tandem Accelerator; Radioisotope Production Facility; National Centre for Radiation Research and Technology (NCRRT) | None of the accelerators are currently able to produce sufficient plutonium for nuclear weapons. |

*Table A.1 Egyptian Nuclear Facilities*