Mosasaurs

*Interactions between armies and ecosystems in the Meuse Region, 1250-1850*

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1. Introduction

1.1 The Mosasaur Genus and the Military

In a hill named Sint-Pietersberg, near Maastricht, labourers digging out limestone found the skull of a large creature resembling a whale or giant crocodile around the year 1780. It belonged to an animal that would have measured fifteen to seventeen meters in length. This remarkable specimen, the Grand Animal de Maastricht, had reached such fame by 1794 that the Commissaires des Sciences et des Arts present with the French invasion army of the Sambre and Meuse, Bartélémy Faujas de Saint Fond and André Thouin, ordered soldiers to search and confiscate it from its rightful owner, the canon Theodorus Joannes Godding. They located the skull on 8 November 1794, only four days after the surrender of the Dutch garrison of Maastricht.\(^1\) It was brought to the newly established Muséum National d'Histoire Naturelle in Paris, where in 1808 the zoologist George Cuvier (1769-1832) identified it as an extinct species of lizard.\(^2\)

The history of this skull is a well-known event in the history of science, but its seminal nature is somewhat overstated. Doctor Johann Leonhard Hoffmann (1710-1782), director of the military hospital of Maastricht, had already come into the possession of similar fossils around 1770, and made his observations known through correspondence with other scientists.\(^3\) He initially believed that they belonged to a crocodile, but later adopted the view of his friend, the anatomist Petrus Camper (1722-1789), who thought they were the remains of a sort of sperm whale. Camper observed that the jaws of the unknown animal were unlike those of crocodiles: they were smooth-surfaced, and there were teeth in the roof of the mouth. Furthermore, the skull was found near fossils of marine life, which in his view made its identification as a crocodile improbable.\(^4\) Hoffmann also stood in close contact to Jean Baptiste Drouin, a former lieutenant colonel, who obtained a more-or-less-complete skull as early as 1766.\(^5\) Adriaan Gilles Camper (1759-1820), Petrus' son, was the first naturalist to classify the animal as a lizard-like creature ('a giant marine squamate reptile with varanoid

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\(^1\) Rompen, 'Mosasaurus Hoffmanni', 37-40; van Schaik, De Sint-Pietersberg, 383.
\(^2\) Bardet and Jagt, 'Mosasaurus hoffmannii'; Cuvier, 'Sur le grand animal fossile'.
\(^3\) Contrary to popular opinion, Hoffmann never possessed the famous skull found in 1780. The French geologist Faujas de Saint-Fond seems to have made up a story of him losing the skull to Godding in order to justify its confiscation by the French government. Faujas de Saint-Fond, Histoire naturelle, 59-67, 215-230; Rompen, 'Mosasaurus Hoffmanni', 37-60; Smit (ed.), Hendrik Engel's Alphabatical List, 125.
\(^4\) Camper assumed that crocodiles only lived in freshwater environments, a supposition we now know to be incorrect. Camper, 'Conjectures'; Lever, 'Johan Leonhard Hoffmann'; Mulder, 'On latest Cretaceous terapods', 16-17; Smit (ed.), Hendrik Engel's Alphabatical List, 125.
\(^5\) Smit (ed.), Hendrik Engel's Alphabatical List, 76-77; van Marum, 'Beschrijving'; van Regteren Altena, 'Achttiende-eeuwse verzamelaars'; van Regteren Altena, 'Nieuwe gegevens'.

affinities') in an article from 1800, and based his interpretation on a study of this latter cranium.\textsuperscript{6}

Figure 1.1 Fictional depiction of the discovery of the Mosasaur Skull in 1780. Doctor Hoffmann stands on the left foreground (Faujas de Saint-Fond, \textit{Histoire naturelle}).

It was not until 1829, however, that the mysterious animal was definitively identified: the English geologist Gideon A. Mantell named it \textit{mosasaurus hoffmanni} in honour of the man who made it famous. Mosasaurus literally means 'Lizard of the Meuse'.\textsuperscript{7} The discovery of these fossils is a landmark in the history of science because \textit{mosasaurus hoffmanni} was one of the first extinct species ever identified. The fact that a species could die out implied that the world as it was known in the eighteenth or early nineteenth century was different to the one God created. It therefore challenged the generally accepted worldview at the time, and paved the way for the evolutionary theory of Charles Darwin. It is typical that Hoffmann identified the unknown creature first as a crocodile, and later as a whale, because it had to fit within existing classifications. The fact that remains of marine species could be found so far inland was seen as proof that the mythical Flood described in the Book of Genesis really happened.\textsuperscript{8}

The area around Maastricht, and the Sint-Pietersberg in particular, is well known for its layers of limestone, which have continued to provide large quantities of fossils until this very day. A new species of mosasaur was discovered here as recently as 1998 (\textit{Prognathodon saturator}). Military men had a key role in the discovery of the mosasaur genus because this landscape had both ecological and strategic value. A forgotten passage from Petrus Camper's

\begin{itemize}
\item \textsuperscript{6} Mulder, ‘On latest Cretaceous terapods’, 17; Rompen, ‘Mosasaurus Hoffmanni’, 62-63.
\item \textsuperscript{7} A prehistoric sea turtle Hoffmann discovered was later named after him as well. de Graaf and Rompen, ‘\textit{Mosasaurus Hoffmanni}’; Rompen, ‘Mosasaurus Hoffmanni’, 77-80.
\item \textsuperscript{8} Buffetaut, A Short History, 54-60; de Graaf and Rompen, ‘\textit{Mosasaurus Hoffmanni}’; Rudwick, Bursting the Limits of Time, 68-70.
\end{itemize}
description of his visit to Maastricht in 1782, mentions that he had to seek permission from the governor to visit the fort on the Sint-Pietersberg, and access nearby quarries. He thus chose the most secluded of at least three possible entry points: a staircase built inside the fort itself. He also seems to have expected a guided tour, and wrote down his disappointment that the governors' orders were not executed properly, for his escorts did not show him anything. An officer apologised for the inconvenience.  

Camper's expectation that members of the garrison would serve as his guides reflects the extent of military control over the area. Inhabitants of nearby villages had been cutting out limestone in this hill since at least the fifteenth century, and some of them would have known their way around far better than any soldier. Officers of both the Dutch and French army expressed considerable interest in the underground network of the Sint-Pietersberg because a besieging army might use it to assault the fort, built in 1702, from below. During the siege of 1794 Dutch and French soldiers actually placed explosives in the quarries to attack their adversaries' positions.  

The close connection between military and scientific exploration is also reflected in the earliest publications dedicated to the Sint-Pietersberg. The French geologist Faujas de Saint-Fond (1741-1819) published the first book-length study of the hill, and the famous

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10 van Schaik, *De Sint-Pietersberg*, 380-388.
skull, in 1799, after a visit to its quarries in January 1795. At least two generals, the botanist André Thouin (1746-1824), and an unknown number of lower-ranking soldiers, accompanied him. He did not incorporate a map of the area in his book, but J.D. Pasteur, who published a Dutch translation of his work, managed to get hold of a map made by a gunner. This was not an official military document, but the officer’s personal possession, and was sold after his death. It illustrates the fort's close proximity to both the Meuse and the fortifications of Maastricht (see figure 1.2). M.L. Mathieu, a French artillery captain, would publish the next major study of the Sint-Pietersberg in 1813. He mentioned that a former officer of the Dutch army accompanied him during his explorations of the underground mining galleries. The naturalist Jean Baptiste Bory de Saint-Vincent, a veteran of Napoleon’s army, followed his example in 1819, when living in exile in the Kingdom of the Netherlands. He rejoined the French army in 1820, and later led the scientific explorations of Greece (1829-1830) and Algeria (1839-1842).

My choice of the title 'Mosasaurs' serves as a suitable metaphor for this analysis, not only for the specific historical circumstances that led to the identification of this genus, but also because it suffers from the same stereotyping as armed forces. Mosasaurs, sea lizards who lived during the Late Cretaceous period (100.5- 66 million years ago), are commonly

![Figure 1.3 Reconstructed skeleton of mosasaurus hoffmanni, Maastricht Museum of Natural History (photograph by the author).](image)

12 Faujas de Saint-Fond, *Natuurlijke historie*, VII-VIII.
13 Mathieu, 'Notice sur les orgues géologiques'.
14 Bory de Saint-Vincent, *Description*. 

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portrayed as destructive monsters. While this particular species, *mosasaurus hoffmanni*, was in fact a huge and fearsome predator (see figure 1.3), it is only one member among a genus of over forty species, which had an important and complex role in the functioning of ecological systems in which they lived. While the largest mosasaurs ate almost everything, including ammonites, nautiloids, turtles, fish, birds, and other mosasaurs, smaller species specialised in eating molluscs, sea urchins, gastropods (snails and slugs), or squid. Different species would therefore have occupied different ecological niches. In the same way, there is no doubt that armies can adopt the shape of large destructive forces of tens of thousands of armed persons who destroy everything in their wake, but as with the *mosasauridae* genus, this is only one aspect of a multifaceted being.

1.2 Ecological Conservation Before Modernity

This thesis considers interactions between armed forces and their surroundings from a long-term perspective, more specifically the Meuse Region in 1250-1850. It argues that armies' conscious and concerted protection and conservation of ecosystems predates the rise of environmentalism by several centuries, and that this supposedly modern behaviour is just one element in a complex web of interconnections between armed forces and ecological systems. In fact, the ecological influences of armies, past or present, can only be understood when one distinguishes between long- and short-term effects. The choice for a time frame of six hundred years is therefore essential for this analysis, and will be further clarified in the following section (1.3). The concepts of 'army' and 'ecosystem' are delineated first.

This study defines an army, or armed force, as a temporary or permanent social group characterised by the fact that its members carry weapons, whose main purpose is the management of organized and collective conflicts in which the use of, potentially, lethal violence is the essential element (war). Such a definition might seem unproductively wide. It emphasizes that function, rather than a debatable numerical minimum or political legitimacy is an army's key characteristic. Setting a minimum limit for the concept of army is even counterproductive in light of the relative growth in army size in 1250-1850.

Furthermore, such a characterization avoids the assumption that warfare inevitably revolves around battles and sieges or that armies can only be raised by 'states'. Many armed forces had a very short lifespan, especially before the late seventeenth and early eighteenth century. They were assembled for a particular purpose, and disbanded afterwards. Even so,

16 This characterization adopts Alexander Moseley and Keith F. Otterbein's definitions of warfare. Moseley, A Philosophy, 14-16; Otterbein, How War Began, 9-10.
17 A useful overview is provided in Lynn, ‘The Evolution’.
marching, standing guard, maintaining fortifications, and simply staying healthy by securing access to food and shelter would have been far more pressing issues on a daily basis than preparing for combat. If an army actually engaged the enemy it was most likely in the context of skirmishes, incursions, and sudden assaults, rather than major battles or sieges. The relative importance commanders attributed to such actions changed over time, and so did the terminology: from the medieval chèvauchée or Reise to seventeenth-century partisan warfare, and eighteenth- or nineteenth-century 'little war' (petite guerre, Kleinkrieg, guerrilla). Still, from the perspective of army-ecosystem interactions these aspects of warfare remain among the most significant.\textsuperscript{18}

This study likewise uses the expression 'army members' when referring to the people who make up an army. While it might seem more logical to opt for terms such as 'soldier' or 'military', this would also mean that the specific meaning of these terms in historical sources is ignored. 'Army members' is in fact much closer to the terminology the sources themselves adopt ('men of war', 'men of arms', 'armed people', 'army people').\textsuperscript{19} The term soldier, of medieval origin (soudener, soudoier, Soldener), derives from Latin solidarius, which is literally 'someone who receives a solidus', a golden coin of the Late Roman Empire, or 'paid man' in a more general sense. It refers to combatants who receive monetary compensation for their services. When the term soldier appears in this study, it is always in this specific meaning.\textsuperscript{20} In a similar way, the term 'military', derives from Latin miles, militaris, and indicates matters relating to war or armies in general (as in military history). It only became the preferred term to refer to a specific kind of army, characterised by uniforms, a strict hierarchy and clear distinctions from the general population ('citizens') during the eighteenth and early nineteenth century. When this study uses the term military it is in the general sense, unless stated otherwise.\textsuperscript{21}

Armies included, and still include, a considerable number of persons in their ranks who cannot be referred to as 'soldiers', and to a lesser extent 'military'. These could be wagoners, servants, pioneers, medical personnel, combatants' partners and children, etc. During the eighteenth and nineteenth century commanders and governments put considerable effort into turning armies into military organisations. These processes entailed that the aforementioned individuals either adopted a more official presence (e.g. the militarizing of

\textsuperscript{18} Lomas, 'Raids and Raiding'; Parker, The Army of Flanders, 12-13; Picaud-Monnerat, La petite guerre; Satterfield, Princes, Posts and Partisans.

\textsuperscript{19} 'Gens de guerre', 'krijgsvolk', 'Kriegsfolk', 'legervolk', 'gewapenden', 'gens d'armes', 'manner van wapenen'. The terms 'gens d'armes' and 'manner van wapenen' could also refer to a dominant group within armies (men-at-arms) or even a social group identifiable by its martial qualities (squires). In medieval Latin miles (plural milites) generally referred to knights specifically rather than combatants in general. Lind, Genesis of the Civilian', 52-53.

\textsuperscript{20} The word soldier spread from French (soldat) to Dutch (solder) around the late sixteenth century, and to German (Soldat) in the early seventeenth century. Schulten, Contribution, 104-105.

\textsuperscript{21} Bardin, Dictionnaire, vol. 12, 3640-3641; Lind, Genesis of the Civilian', 59-64.
transport services and administration) or were excluded from army contexts (e.g. women and children).\textsuperscript{22}

Figure 1.4 Fifteenth-century army on the march (BRB, ms. 9242 Chroniques du Hainaut, f.184r.).

Figure 1.5 French army advancing on Maastricht in 1748, Etch from 1771 (RA, RP-P-OB-83.859).

This process can be illustrated by comparing a fifteenth-century miniature from Hainaut, depicting an army on the march (figure 1.4), with an eighteenth-century etching portraying the advance of a French invasion force toward Maastricht in 1748 (figure 1.5). The medieval

\textsuperscript{22} Cardoza, \textit{Intrepid Women}, 166-228; Mayer, \textit{Belonging to the Army}; Tachon, \textit{Enfants du troupe}, 225-240.
army consists of soldiers on foot and their families. They leave a trail of demolished buildings behind and carry their plunder along in wagons. Their early modern successor consists of an endless row of wagoners and soldiers. The latter also wear uniforms. Women and children by contrast are not illustrated, which can be considered symbolic for the fact that their presence had already become much reduced by this time. The wagoners in the foreground, who transport pontoons to construct a temporary bridge over the Meuse, would just have been hired for a temporary period, and were not yet considered part of the military establishment. 'Army' and 'military' only became fully synonymous during the nineteenth century. In recent years scholars have started to question this close association again, by referring to the rise of private security companies and the blurring of distinctions between military and police forces in the fight against terrorism.23

Establishing a clear definition of the second cornerstone of this thesis, ecological system or ecosystem, is no less problematic. The concept conventionally refers to all of the organisms, meaning plants, animals, fungi, and microorganisms that live in a particular habitat (a community or multiple communities), along with their immediate physical and chemical environment. Living and non-living elements constantly interact with each other through flows of energy and matter (e.g. food chains). In theory, the term ecosystem cannot be limited to a certain spatial or temporal level. The Meuse River itself is an ecosystem, but so is a forest or a lake. Some might argue that the whole globe is one huge ecosystem.24

This very lack of spatial and temporal limitations makes the term both thought-provoking and problematic. The concept of an ecological system was originally developed in the early twentieth century; the term was coined in 1935, on the basis of lakes. These constitute closed systems that can be reasonably well defined in spatial terms. In most cases, and the Meuse Region is a good example of this, it is very difficult to pinpoint where one ecosystem ends and another begins. The fact that 'everything is connected to everything else' does not help either. Many scholars therefore prefer to examine a single aspect or level within ecosystems, such as the non-living environment (landscapes), living beings (biotic communities) or even pathogens (organisms or materials that cause disease) and individual species.25

In order to approach the subject in a systematic way this study adopts these same distinctions. The first two chapters, frontiers and fortifications, represent the landscape level or the non-living environment, comprising soil structure, hydrography, and land use. Landscapes are considered here as ecological milieus that are created through the mutual engagement of environment and people. A landscape is simultaneously a material reality and

24 Park and Allaby, Dictionary, 135; Chapman and Reiss, Ecology, 187; Willis, 'The Ecosystem', 270.
25 Golley, A History; Raffaelli and Frid, 'The Evolution'; Willis, 'The Ecosystem'.

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a cultural construct.\textsuperscript{26} The next two chapters, disturbances and policing, are concerned with living beings or fauna and flora (humans, animals, and plants). The final level comprises only one chapter, army health, and examines pathogens, or disease and disease prevention. These distinctions are not absolute, but should be seen as a shift in emphasis, as no single aspect of the ecosystem concept can be studied in isolation. Such a methodology also fits into the traditional geographical understanding of a region as multiple landscapes that share similar characteristics. The Meuse Region is composed of several distinct landscapes that are nevertheless related because they are part of the same riverbasin, and these landscapes in turn comprise divers kinds of living beings and pathogens.\textsuperscript{27}

Despite the ambiguity of 'ecosystem' as a concept, it still provides a suitable framework to think about the natural world in a way that more traditional notions, such as 'nature' and 'environment', do not allow. It does not assume for instance that humans are fundamentally different from the world that surrounds them. Its rising popularity from the 1970's onwards originates to a large extent in its adoption by environmentalist movements. What is important for this study is that it allows the organizing of complex interactions between armies and their surroundings in a manner that is meaningful to military and environmental historians, or to historians and researchers of other disciplines. The concept of ecosystem provides a sound theoretical basis, while the actual chapters concern themselves with one of the three levels encompassed by the ecosystem concept: landscapes, biotic communities, and pathogens.\textsuperscript{28}

It might seem contradictory to stress interconnections between humans and the natural world while making human actions the main object of study. Richard Hoffmann has recently proposed the concept of 'hybrid systems' to bridge the traditional divide between 'nature' and 'culture'. He argues that nature and culture should be interpreted as interacting yet autonomous entities. Nature can exist without human intervention, and human ideas or creations (culture) do not necessarily correspond to the actual natural world. Still, perceptions of nature have very real and significant influences; gardens are an excellent example. The term 'hybrid' refers to this close entanglement of cultural and natural elements and more particularly to the fact that human influences are part of ecological systems without being

\textsuperscript{26} Many different definitions of 'landscape' exist, depending on one's field of study. In ecology for instance, landscapes can also be studied as units consisting of multiple ecosystems or ecotopes (the smallest homogeneous mapable units of land). This description focuses on the socio-cultural dimensions of the word landscape to emphasize the close entanglement of 'nature' and 'culture'. Förster, et al., 'Landscape'; Ingegnoli, Landscape Bionomics, 3-9, Jones, 'The Elusive Reality of Landscape', 232-234.

\textsuperscript{27} Baker, Geography and History, 109-129.

able to control them completely.\textsuperscript{29} This thesis agrees with the general idea of hybrid systems, but does not adopt the terminology, because it might lead to unnecessary confusion. If one accepts that the term ecosystem in itself emphasizes connections between living and non-living beings, including humans, there is no need for yet another term. Human perception of the environment can easily be examined as a factor of importance regarding interactions within ecosystems.

A study of reciprocal influences between armies and ecosystems is therefore an analysis of exchanges between ecosystems in general and one of its specific components. In more practical terms this means highlighting interventions by armed forces, while acknowledging that many factors, natural as well as cultural, contributed to actual ecological results. The fact that military domains today have relatively high biodiversity value derives to a large extent from the ways military forces use them, but at the same time the influences, the agency, of other human actors, plants, animals, soil structure, etc. cannot be ignored. As this thesis wants to argue that historical armed forces had a significant impact on ecological systems, it needs to demonstrate that a certain ecological consequence would not have occurred, if armies had not intervened.

1.3 The Meuse Region, 1250-1850

The Meuse Region or the basin of the Meuse River, meaning the river itself and its tributaries, constitutes the geographical framework of this study.\textsuperscript{30} The Meuse River measures about 925 kilometres, ranges from Pouilly-en-Bassigny on the plateau of Langres (Lorraine), at an elevation of 409 metres, down to the North Sea, and is part of a basin that stretches over 34000 square kilometres. Because it is mainly fed by rainwater, the Meuse's behaviour can be quite unpredictable, a characteristic of considerable importance for army-ecosystem interactions (see chapters 2 and 3). Today it is officially referred to as the Meuse from Meuse-en-Bassigny onwards. The initial watercourse is simply known as 'the Brook' (\textit{le Ruisseau}).\textsuperscript{31}

\textsuperscript{29} Hoffmann, \textit{An Environmental History}, 5-20.
\textsuperscript{30} The most important tributaries of the Meuse are, from source to estuary: Saônelle, Mouzon, Vair, Chiers, Bar, Sormonne, Semois, Viroin, Hermeton, Lesse, Molignée, Bocq, Houyoux, Sambre, Mehaigne, Hoyoux, Ourthe, Berwinne, Voer/Fouron, Geer/Jeker, Geul, Geleenbeek, Rur/Roer, Neer, Swalm, Niers, Raam, and Dieze.
The Meuse Region, 1250-1850

This map gives a general overview of the Meuse River and its main tributaries. The coastline reflects the situation around 1250.

- Present borders
Map 1 provides a geographical overview of the Meuse Region. It depicts the Meuse River itself, its tributaries, and the most important cities and landscapes in the context of this study. This map shows that the Meuse Region is relatively sparsely populated, especially if compared to the neighbouring Scheldt basin, and that the most important cities lie alongside the Meuse River itself. Current political borders are illustrated as dotted lines. The Meuse estuary reflects the situation around 1250 in order to draw attention to the processes of land reclamation that occurred in this area during the medieval and early modern period.\textsuperscript{32}

The choice for a geographical approach, inspired by Fernand Braudel's famous monograph on the Mediterranean, serves as an alternative to the traditional emphasis on political entities, and more particularly nation states. This is not to say that the concept of 'region' is unproblematic. Its role in geography is similar to that of 'period' in history. The Meuse Region from an economic or political point of view does not necessarily correspond to this geographical framework. The importance of the Meuse as a political boundary for the Kingdom of France, for instance, far extends these geographical limits.\textsuperscript{33}

The basin of the Meuse as a subject of study is valuable because it provides a geographical framework that is relevant for both military and environmental history. If historians refer to the Southern Netherlands as the 'battlefield' or 'cockpit' of Western Europe, then the Meuse valley certainly is a highway to that battlefield. Rivers were crucial to military movement, especially before the invention of railways, for several reasons: they considerably facilitated the transportation of heavy equipment and supplies, provided relatively clean (running) water and served as a defensive line (see also 2 and 3). It is hardly surprising therefore that the Meuse Region assumed considerable strategic importance from at least the Late Roman Empire to the World Wars (with the struggle for Verdun in 1916 and the battle of the Bulge in 1944 as the best known examples). The role of the Meuse is in this sense quite similar to that of other major rivers, such as the Rhine and Danube.\textsuperscript{34}

A comparison of the Meuse and Rhine is of particular interest here because of their proximity. Some geographers might even argue that the Meuse River is a tributary of the Rhine. While the symbolic value of the Rhine as a boundary between France on the one hand and Germany on the other is well known, this perception is a relatively recent phenomenon. In the broader historical context of this study the Meuse Region has been far more important as a boundary marker between the kingdom of France on the one hand and the Holy Roman

\textsuperscript{32} I am grateful to Jop Mijwaard (Softmap cartographic design) for drawing three original maps of the Meuse Region. The first gives an geographical overview of the Meuse Basin, while the second and third depict the political framework in 1250 and 1789.

\textsuperscript{33} Baker, Geography and History, 156-182.

Empire, dominated by the Habsburgs, on the other (see 2). The linguistic and political variety of the Meuse Region is also more considerable than that of the Rhine, especially if the former's smaller geographical dimension is taken into account. In this way, this study transgresses different historiographies organised by nation states.  

Diversity within the Meuse Region is indeed crucial to this study. Being part of a geographical belt that stretches from Northern France and the Low Countries to the western part of Germany and Northern Italy, and is well known for incorporating some of the most densely populated areas in Europe, the Meuse Region stands out because relatively sparsely populated areas dominate it. The riverbanks of the Meuse River are very fertile and so are a handful of other areas, characterised by fertile loam or clay soil, such as Hesbaye. If the Meuse Region is considered as a whole, however, mountainous forests (Woëvre, Argonne, Ardennes, Eifel) and peat or heath lands (Hohes Venn, Campine, Peel) are the most common landscapes. Many armed forces have been drawn to the Meuse Region because of its strategic importance, but most of them preferred to remain in these fertile lands, especially the rivervalley of the Meuse itself (see 2).

The soil characteristics of the Meuse Region are also important when it comes to construction materials. Some settlements, especially in the southern and middle parts of the basin, had access to relatively large quantities of wood, while inhabitants of the lands near the Meuse estuary started to run out of suitable construction wood as early as the High Middle Ages (see 4). The local presence or absence of raw materials, such as wood, coal or stone, had a substantial impact on trade patterns along Meuse River, because river transport was mainly limited to such high-volume, low-value goods. The valley of the Meuse from Givet to Maastricht is well known for its layers of limestone, which come very close to the surface. Because of the presence of calcium carbonate these landscapes contain unique vegetation that only grows on calcareous soils. Many sites, including the aforementioned Sint-Pietersberg, have now received special protection because of the rare species that live there (notably herbs, flowers, butterflies, and bats). This might seem to be a logical consequence of their inherent geographical features, but some of the most valuable ecosystems are actually manmade (grasslands and quarries). The dominance of limestone as a building material is of major consequence for the ways fortifications in the Meuse Region interact with ecosystems at large, especially in a long-term perspective (see 3).

The chronological limits of this study, 1250-1850, reflect the general emphasis on a long-term perspective. These parameters do not constitute absolute boundaries, but serve, in the same way as the geographical scope, as an alternative framework. They transgress

35 Febvre and Demangeon, *Le Rhin*.  
traditional chronological divisions and bring the importance of the High Middle Ages as a transformative period in European history to the fore. As will be argued below, the High Middle Ages were characterised by a series of changes - environmental, social, economic, cultural, military etc. - that constitute a background or framework that remains dominant until it was replaced by another series of changes during the nineteenth century. The main turning point is around the year one thousand, or the years 1000-1300 more generally, rather than the fifth or fifteenth century. This is not to argue that the 1250-1850 period did not experience significant changes, only that many historians privilege such transformations above forms of continuity with the Middle Ages. The object is to open up research perspectives, rather than to replace one determinism with another.\textsuperscript{38}

Landscapes that are considered archetypical for specific areas in the Meuse Region, or even as 'natural' landscapes, such as the ponds of Woëvre, the heathlands of the Hohes Venn or the Dutch coastline, were to a large degree created during the Middle Ages. Environmentalist organisations put much effort into recreating or maintaining such ecological milieus because they encompass species that can be found nowhere else. Paradoxically this often involves cutting down the very forests and trees that for many people represent true 'nature'. They are also aware that these landscapes have become much scarcer or even disappeared because of changes in land use, particularly during the last hundred and fifty years. Few of them realise, however, that they are to a large extent recreating medieval landscapes.\textsuperscript{39}

These landscapes both originated in and brought about changes in agricultural practices (e.g. the three-field system) that supported significant demographic growth during the High Middle Ages. The extent of this growth is reflected in the fact that most of the settlements that currently exist in the Meuse Region can trace their history back to exactly this period. The great majority of cities today already obtained city rights during the Middle Ages. It is noteworthy that the few exceptions to this general pattern often have a military origin (e.g. Charleroi, Leopoldsburg). Of no less importance is that these settlements built specific stone structures; fortresses ('castles'), city walls, and churches, which retained a major military role until the eighteenth or nineteenth century (see 3). This same period also saw the development of an ideology centred on the 'Three Orders' (those who pray, those who fight, those who work), even if the reality could be rather more complex. The association of nobility with knighthood is of particular importance for subsequent chapters (see 3 and 5). Finally, the

\textsuperscript{38} See especially Gerhard Dietrich, \textit{Old Europe}.

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development of a money economy also encouraged the renewed spread of paid military service (soldiers) for the first time since the Late Roman Empire.  

The political fragmentation of the Meuse Region came about during this period as well, notably as a result of the disintegration of the Duchy of Lorraine (Lotharingia) into a multitude of relatively small principalities. The first division, between Upper and Lower Lorraine in the second half of the tenth century, was quickly followed in the eleventh century by a further series of separations, as local aristocrats consolidated their power. By 1250 the following principalities had emerged, as illustrated in Map 2: the duchies of Lorraine, Brabant and Limburg, the bishoprics of Verdun, Liège and Toul, and the counties of Bar, Champagne, Rethel, Chiny, Luxemburg, Hainaut, Namur, Loon, Guelders and Holland. Furthermore, there were several more or less independent lordships, principalities and cities, such as Commercy (from the Germanic *marka*; march), Stavelot-Malmédy and Aachen.

Despite numerous attempts at political unification (see 2), the Meuse Region remained very fragmented from a political point of view. Map 3 depicts the Meuse Region on the eve of the French Revolution. The borders of the kingdom of France closely resemble the current situation, while the northern half of the river basin was divided among various rulers as well as the Dutch Republic. Ecclesiastical territories, such as the Prince-Bishopric of Liège, were a major factor of continuity because their survival did not depend on the fortunes of one family. French expansion from 1792 onwards briefly united the entire Meuse Region, but new separations followed in 1814-1815 (division of the northern half of the basin between the Kingdoms of the Netherlands and Prussia) and 1830-1839 (secession of Belgium and Luxemburg).

In this way, this thesis emphasizes the importance of a 'peripheral' region that has received far less attention in historical studies of the late medieval and early modern Low Countries than neighbouring 'core' regions (Flanders, and the more densely populated parts of Holland and Brabant). This is partially the result of the relative availability of source material, but the fact that the history of this region does not fit well into traditional narratives of the rise of the Burgundian/Habsburg composite state or the Dutch Republic, certainly plays a role as well.

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41 Alberts, *Overzicht*; MacLean, 'Shadow Kingdom'; Milis, 'Counts, Cities, and Clerics'.

42 The boundaries of the counties of Champagne and Rethel as well as other components of the kingdom of France are not illustrated because they did not constitute frontiers, as defined in this study. For the same reason the lordships of Breda and Briey have been given the same colour as respectively the duchy of Brabant and the county of Bar.
The choice for specifically 1250 as an approximate chronological limit rather than any other year within the High Middle Ages, is a practical measure. The aforementioned developments largely occurred during the eleventh and twelfth century, as argued by R. I. Moore, and encouraged an exponential increase in the number of written sources, often in the vernacular rather than Latin (especially accounts, but also charters, chronicles etc.). Still, as far as the Meuse Region is concerned, relatively few written sources have been preserved that allow a systematic and convincing study of connections between armed forces and ecological systems in 1000-1250. Furthermore, aspects of army-ecosystem interactions that will be presented as characteristic for this research period, such as particular stone fortifications, the predominance of soldiers in armed forces, and the garden-wilderness dichotomy were only fully developed by 1250.

The claim that frameworks established during the High Middle Ages only lost most of their significance during the nineteenth century can best be illustrated with two examples: gunpowder weapons and the so-called Columbian exchange. Military historians traditionally attribute great importance to the fifteenth and sixteenth century because of the effects of gunpowder weapons on fortification architecture. While such devices did become relatively more efficient during those centuries, historians often neglect to emphasize that gunpowder already spread to Europe during the thirteenth century. The oldest written reference to a gunpowder weapon in the Meuse Region comes from the 1346 city accounts of Aachen: an iron gun that shot arrows. It took almost three centuries (thirteenth-sixteenth century) before gunpowder weapons transformed the way (new) stone fortifications were constructed. Another century would pass before the need to carry gunpowder weapons caused a divergence between warships and other types of vessels. As far as battlefields are concerned, gunpowder weapons did not end the continued prevalence of melee weapons before the nineteenth century.

In a similar way, overseas travellers brought all kinds of new plants to the Meuse Region from the sixteenth century onwards, but very few of them spread beyond (botanic) gardens. The cultivation of tobacco, for instance, became quite common during the seventeenth century, but this plant requires a relative intensive garden-like cultivation. The same applies to the potato, which was only widely adopted at the end of the eighteenth and beginning of the nineteenth century. The number of neophytes, new plants that were introduced after 1500 and could survive independently of human aid, was negligible before major changes in transportation during the nineteenth century, especially if compared to the

43 Moore, *The First European Revolution*.

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large number of archaeophytes; plants that were introduced and established themselves before the Columbian exchange (e.g. good king henry, wormwood, common snapdragon). It is often very difficult to distinguish these from actual 'native' plants.\textsuperscript{46} A comparison of animal introductions is also revealing: archaeozoological research and fiscal accounts indicate that turkeys ('Indian peafowl') lived in a handful of prestigious lordships during the sixteenth century (e.g. the castles of Breda, Eindhoven and Pietersheim), but this handful of animals seem barely relevant in light of the medieval introductions of the rabbit and domesticated carp (see 6).\textsuperscript{47}

The fundamentals of army-ecosystem interactions only transformed during the nineteenth century. Some of these changes were technological: railroads (1830's), ironclad warships (1860's), the general adoption of breech loaders (1840-1870), the machine gun (1860's), the construction of detached fortifications made of concrete and steel rather than stone and wood, and barbed wire (1870-1890). It is also during the nineteenth century that the first large-scale attempts were made to channel the Meuse River itself.\textsuperscript{48} Others were of a more social nature, such as the militarizing of armies and the adoption of personal military service (see 5). Major developments in the iron industry and coalmines altered landscapes in the middle of the Meuse basin, from Charleroi to Liège. It is also at this time that agricultural practices lost their medieval roots, with the last elements of medieval practices disappearing one by one (e.g. the end of communal lands and small-scale ownership).\textsuperscript{49}

The need for wider chronological limits is imperative given the 'Military Revolution' paradigm, which became the subject of major debates in the 1990's, but still looms large within the field of military history. Michael Roberts coined the term in 1955, at which time it denoted a series of, mainly tactical, changes in the Dutch and Swedish army during the 1560-1660 period. Geoffrey Parker developed this thesis further. He expanded its geographical, chronological and thematic range by taking other parts of Europe, notably the Habsburg Empire, the early sixteenth century, and technological advances into account. Furthermore, he added a key, but very controversial claim: that the Military Revolution as he defined it

\textsuperscript{46} Preston, Pearman and Hall, ‘Archaeophytes'; Schroeder, 'Zur Klassifizierung'; Zeven, De Introductie.
\textsuperscript{47} Coenegrachts and van de Konijnenburg, ‘De kasteelsite van Oud-Rekem'; 64-65; de Jong, 'Huisdieren, jachtwild, vissen en weekdieren', 222-223; Lauwerier and Zeiler, 'Wishful Thinking'; Marchal, Inventaire, 174; Nagels, Kerklaan and van Kaam, Kasteel van Breda, 16, 52; Schorger, The Wild Turkey, 464-473; van Dam, 'Rabbits'.
\textsuperscript{48} This applies to the Meuse River as a whole. Human interventions at the most local level, notably dike building, altered the course of the Meuse significantly and repeatedly during the Middle Ages and Early Modern Period (see 1 and 2). Breuer, Die Maas, 95-123; Guillery, La Meuse; McNell, The Pursuit of Power, chapter seven.
\textsuperscript{49} Dejongh and Thoen, ‘Arable Productivity'; Lebrun et al., Essai sur la révolution industrielle; Parmentier, Pays de Charleroi.
explained why European armies could dominate or colonise other continents in subsequent centuries.⁵⁰

Numerous historians, such as Jeremy Black, John A. Lynn, David Parrott, Clifford Rogers, and more recently Tonio Andrade have criticised this concept for being Eurocentric, teleological, and technology driven, and for its loose use of the term 'revolution'. At the same time they have also supported and expanded it. Parker's argument fuelled considerable reaction because he combined basic problems regarding military change with a much larger question: 'when does modernity start?'. The thesis did influence Charles Tilly's studies on state formation in Europe to no small extent. A considerable part of the criticism has therefore focussed on the specific chronological or geographical framework, many researchers being anxious to prove that the subject they specialised in contributed to, if not actually brought about, a military revolution and thus the rise of modernity.⁵¹

The assumption that 'revolution' is a suitable concept to understand military change was also questioned, but to a more limited extent. Clifford J. Rogers, who incorporated the Hundred Years War (1337-1453) in the Military Revolution thesis, proposed a framework of evolution rather than revolution. Still, he also claimed that intervals of more rapid change existed, such as in the fifteenth century. Many military historians consequently refer to multiple 'military revolutions' or 'Revolutions in Military Affairs' (RMA), which entailed transformations in military doctrines as well as technology. In this way, they respond to criticism on the 'Military Revolution' concept, but the fundamental assumptions underlying it remain unchanged. The supposed changes during the fifteenth-century military revolution for instance, the 'gunpowder' and 'infantry revolution', can also be traced back to the High Middle Ages.⁵²

The aim of this thesis is not to add yet another period to an existing series of military revolutions, but to question the concept on a more fundamental level, by studying continuity and change across a period during which several of these transformative changes supposedly took place, and in a region which Parker identified as part of a core zone in which his 'Military Revolution' first came about.⁵³ Making interactions between armies and ecological systems the subject of this thesis means bringing different rates of historical time to the fore again and provide an alternative framework for understanding military change during the longue durée. Braudel's well-known study of the Mediterranean world at the time of Philips II

⁵² Ayton and Price, 'Introduction'; Black, Rethinking Military History; Prestwich, 'Was There a Military Revolution'; Williamson and Macgregor, 'Thinking About Revolutions'.
⁵³ Parker, The Military Revolution, xvi-xvii.
has been criticised for geographical determinism, but he did note that different rates of historical time (geographical, economic and political-military) could influence each other.\textsuperscript{54}

Because of the general emphasis on long-term influences political events and individual rulers occupy a far less prominent place in this analysis than in most works concerned with military history. The thesis rather assesses the ecological aspects of state formation, as well as the agency of common soldiers, their families, animals, plants, and the Meuse River itself; actors that historians have often been neglected or taken for granted.

1.4 Historiography

By drawing attention to armed forces' historical role in the preservation of ecosystems, the thesis contributes to current debates about the ecological impact, the 'environmental footprint' of military forces. These discussions date back to the 1960's and particularly the Second Indochina or Vietnam War (1955-1975), which saw the massive use of pesticides (the infamous Agent Orange). This fuelled an increasingly powerful peace movement, and also prompted some of the first academic studies on the ecological effects of warfare. Arthur H. Westing, a biologist who saw active service in the U.S. army, played a pioneering role in this regard. He was one of the first researchers to study environmental destruction in wartime and the need to devise measures to prevent, or at least reduce, these effects.\textsuperscript{55}

By the late 1980's and early 1990's environmental organisations went a step further and criticised armed forces' role in large-scale pollution and environmental degradation in both war and peace. The continuous connection of such critics with the peace movement is made clear by a small German edited volume from 1988, which is titled \textit{Natur ohne Frieden}, 'Nature without Peace'. The cover page depicts a tank riding down a tree with a peace dove flying over it.\textsuperscript{56} Conservationists were also quick to make comparisons with historical examples. Gerd Schuster, editor of the journal \textit{Natur}, argued that 'a mentality of medieval mercenaries governs at least the higher echelons of the (West) German Army'. Another journalist equated that same army with 'medieval robber barons'.\textsuperscript{57} The presumed similarity to medieval mercenaries is of particular interest within the context of this study because it

\textsuperscript{54} Braudel, \textit{La Méditerranée}, Kinser, 'Annaliste Paradigm'; Latham, 'Warfare Transformed'.
\textsuperscript{56} Achilles (ed.), \textit{Natur ohne Frieden}; Gleditsch, 'Armed Conflict and The Environment'; Skrotzky, \textit{Guerres}; van Mourik, van Teijlingen, and Vertegaal, \textit{De natuur onder vuur}. For the idea that warfare is atypical for or incompatible with modernity see Joas and Knöbel, \textit{War in Social Thought}.
\textsuperscript{57} 'Allzu deutlich war nämlich geworden, dass zumindest in höheren Riegen der Bonner Verteidigungsarmee- eine Art mittelalterliche Söldnermentalität herrschte'. Lange, 'Raus aus den Kartoffel', 209; Schuster, 'Täuschen und Tarnen', 14.
reveals that the stereotyping of the Middle Ages is both explicit and implicit. The modern German word for mercenary (Soldner) is also the medieval German word for soldier.  

It is unclear to what extent the sheer horror of being called 'medieval' contributed to a change in attitudes, but military organisations have put substantial effort into presenting a different image to the general public from the 1980's onwards. Every self-respecting military force, be it national, or international (NATO), now has a specific webpage dedicated to presenting an image of an organisation for which environmental conservation is a major concern. Such websites invariably refer to military domains, which are increasingly turned into natural reserves during the last decades, or at least receive special protection because of their biodiversity value (Camp de Suippes, Kamp van Beverlo, the Dutch military domains on the Veluwe). In recent years they have facilitated the comeback of wolves in Western Europe.  

There is also an increasing awareness among conservationists of the ecological value of former militarized landscapes as unique environments (see chapters 2 and 3). Abandoned bunkers from the World Wars have become the home of bat colonies, and the demilitarized zone between North and South Korea constitutes a rare paradise for endangered species. The Indian army has special 'Environmental Task Forces' to carry out afforestation and irrigation projects, particularly near the frontiers with Pakistan, Bangladesh, and Nepal, while the armed forces of countries such as South Africa and Botswana can claim that they actively protect wildlife against poachers (see 5).

The ways that the historic past is used within these important, but also very complex, debates, is striking. There is a clear tendency to either ignore historical examples of the close entanglement between armies and ecological systems altogether, or refer to them in a simplistic manner ('mercenaries', 'robber barons'). This is based on two more or less contradictory assumptions. The first supposition is that due to technological 'backwardness', historical armies were not able to influence their environments in a cognisant and meaningful way and are thus not relevant to current debates. The second assumption is that armed forces have always been destructive, even though their potential impact on ecological systems did

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58 Sikora, 'Söldner'.
60 A visit to the military domain 'Kamp van Beverlo’ in the summer of 2009, as a member of the Jeugdbond voor Natuur en Milieu (JNM), was a major inspiration to start considering historical interactions between armies and ecological systems. Brunel, Les missions militaires; de Wolf and Fautsch, 'Les sites militaires'; Gilissen, Missie natuur. For a critical discussion of military forces’ rhetoric, see Coates et al., ‘Militarized Landscapes’, Woodward, 'Khaki Conservation'; Woodward, Military Geographies, 85-103.
increase with technological developments. In both instances, however, protective or non-
destructive behaviour is presented as something 'new', as an accomplishment of
environmentalism, environmental organisations and modern military forces.

Historians have certainly picked up on these themes and made their own contribution
to these debates: in the last decade several monographs have been published on the
environmental consequences, mostly devastation, of the American Civil War, the World Wars
and the Cold War. A growing number of works are also concerned with the impacts of
disease or weather and climate on the conduct of warfare. These analyses have favoured
rapprochement between military and environmental history, and it is perhaps even possible to
speak about a 'green turn' in military history. Still, environmental studies relating to warfare
before 'modernity', before the industrialisation of warfare in the nineteenth century remain
quite rare. The works of J.R. McNeill and Richard P. Tucker need especially to be mentioned
here.

Other scholars, from the field of history as well as archaeology and literature, have
also contributed significantly to the study of army-ecosystem interactions even though they
do not link themselves explicitly to debates about the 'environmental footprint' of the military.
John Childs' *The Military Use of Land* for instance examines the use of land by military
forces in the literal sense, that is without considering actual ecological consequences, but to
this day it is one of the few major studies to consider the phenomenon across traditional
chronological and geographical boundaries. The book remains a valuable reference work
alongside more detailed analyses, such as those of Aleksander Pluskowski and Thomas R.
Trautmann. The former demonstrated, on the basis of archeozoological and archeobotanical
evidence, that the Teutonic Order transformed Prussian landscapes through its promotion of
agricultural expansion, woodland clearance, horse breeding, and hunting. The latter published
a thought-provoking investigation into the use of war elephants in India, which also involved
the protection of wild elephants and elephant habitats. Ecocritical studies, such as those of

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65 Childs, *The Military Use of Land*. 
Jeremy Withers, have covered new ground by analysing chivalric attitudes towards nature and animals in warfare.66

The understanding that armed conflicts constitute a significant part of the ways humans interact with ecological systems is actually well established within anthropology for several decades, but there has long been a strong reluctance to use the term 'warfare', because many scholars prefer to stress the peaceful nature of the societies they study. Military historians on the other hand have largely ignored these examples, considering them irrelevant for 'civilised' or 'state organised' warfare. The last decade, however, has seen an increasing number of studies that explicitly refer to 'prehistoric warfare'. Several of these analyses concern themselves with the question to what extent warfare can be considered as a biological process, as an essential part of human evolution.67

The emphasis on evolution is important because most historical research on army-ecosystem interactions focuses on fighting, and exceptionally its immediate prelude and aftermath. Yet Charles Darwin's evolutionary thesis is still the dominant paradigm within biology. Evolution is a relatively slow process that takes centuries or thousands of years. In such a framework, the handful of years or decades of a particular war are quite insignificant. This also means that it is very difficult to predict future ecological consequences of present-day events, for even though specific wars might be brief, they could have long-lasting effects. What is possible, however, is to look at the ecological effects of past military actions and armed forces, for armies can exist in peace as well as war.

The fact that many scholars prefer to speak about 'the environmental impact of war(fare)', or 'war and nature', is significant in itself.68 It reveals a focus on short-term effects, and a lack of theoretical clarity, for environment and nature are very vague concepts. Such a concern for short-term historical change might be more typical for military than environmental historians, but in the last decade studies concerning 'natural disasters', including extreme weather and earthquakes, have actually become increasingly common within environmental history. Moving from natural disasters to warfare is but a small step (see also chapter 4).69

Moreover, the understanding that environmental factors, such as geography, or weather and climate, influence armies and warfare is probably as old as military history itself.

66 Davis Hanson, Warfare and Agriculture; Hevia, Animal Labor and Colonial Warfare; Hill and Wileman, Landscapes of War; Ouchley, Flora and Fauna; Plukowski, The Archaeology, 294-326; Spring, Great Walls; Trautmann, Elephants and Kings; Withers, 'Forests, Animals, and Ambushes'; Withers, 'The Ecology'.
67 Ferguson, 'Ecological Consequences'; Fry, 'War, Peace, and Human Nature'; Otterbein, How War Began; Thorpe, 'The Ancient Origins'.
69 Pfister, ‘Historical Climatology’; Schenk, ‘Common Grounds’.
The field of military geography as it still exists today largely developed in the nineteenth century.\textsuperscript{70} It is particularly revealing that F.H.A. Sabron, captain in the Dutch general staff, published tables with mean temperatures as early as 1893, in his monograph on Dutch defence against French invading forces in 1794-1795. These tables served to demonstrate that extremely cold temperatures hampered Dutch efforts. The freezing of the Meuse and other major rivers in fact nullified the defensive value of the Hollandic Water Line. Military historians have long been aware of environmental pressures; they just did not look at them in the same way environmental historians study them now.\textsuperscript{71}

1.5 Sources: Selection and Problems

Studying interactions between armies and ecosystems in a timeframe of six hundred years and a multilingual context creates evident challenges. The continuous strategic importance of the Meuse Region has also had the unfortunate result that warfare related damage caused a considerable loss of archival material. In 1940 for instance most of the medieval and early modern archives kept in Mons and Mézières went up in flames.\textsuperscript{72} Distinctions between institutions, or different kinds of armies, have to be taken into account as well, for they imply the production of different kinds of sources. There are relatively few administrative sources available for the medieval Prince-Bishopric of Liège, but this is compensated by an exceptionally rich corpus of chronicles. One can also fill gaps in documentary records in one area of the Meuse Region by studying a different area of the same region. This only applies, however, if no significant dissimilarities exist.

Despite these issues, the geographical and chronological extent of this study is such that finding potential sources has rarely been a problem. The main concern proved to be their selection. While relatively little research has carried out so far on historical army-ecosystem interactions, an almost endless list of literature exists that comments on the subject in a direct or indirect way. Even the most traditional example of a battle history is likely to note the effects of weather and terrain on military operations, or the supply of wood for a siege, without further elaboration. Given the relatively limited timeframe to conduct this research, it focuses on a select corpus of archival documents that give a unique perspective on the subject. These are often sources that have been rather neglected in historical research up to this point. The eighteenth-century garrison orders of Namur for example are an important reference throughout this study. These series of commands given to the members of the Dutch

\textsuperscript{70} Boulanger, \textit{La géographie}, 16-55; Harmon, Dillon and Garver, ‘Perspectives’; Schroeder, ‘Development’.

\textsuperscript{71} Sabron, \textit{De oorlog}, vol. 2, XXXII-XXIII.

garrison give a unique insight into their connections with local ecosystems. It is also a source that has rarely been preserved elsewhere, possibly because governors did not have to send copies to the capital.\textsuperscript{73}

In a similar way, this thesis had to cope with a disparity between a relatively limited number of medieval sources and a mass of eighteenth- and nineteenth-century documents. Given the emphasis on the Middle Ages as a framework on which developments during subsequent centuries rest, a deliberate choice has been made to ensure that medieval sources are well represented throughout the five chapters. This inevitably means that the research potential of later sources could not be used to their full extent. The argument rather relies on sources that, like the aforementioned archival documents, provide an original perspective on military-ecological interactions. The chapter on fortifications for instance does not dwell on the numerous plans and maps drawn by engineers from the seventeenth century onwards, which have become an invariable part of almost any history of military architecture, but brings the publications of nineteenth-century naturalists to the fore. Their works provide an exceptional insight into the biodiversity of early modern defences at a time when they still had garrisons.

Finally, for some sources the main criterion has simply been access to transcriptions or detailed inventories. Legal acts, written down by notaries or councillors, or fiscal accounts provide a useful perspective on almost any topic, but one has to read systematically through a large numbers of folios to find relevant references. Sixteenth- and seventeenth-century councillors' acts for instance contain detailed testimonies of war-related damage, witness accounts that would otherwise never have been recorded. Voluntary hearings in particular had to record an individual or group's view on certain events, generally in the context of a conflict or trial. Medieval fiscal accounts are of special interest because they tend to group all costs of a military activity in a single document. Establishing the expenses of an early modern army is much more difficult because of a growing distinction between military units on the one hand and local populations, who still had to support the former, on the other. Studying the fiscal accounts of local communities is straightforward enough, but the internal administration of military units has rarely been preserved before the eighteenth century.

Aside from written sources, other types of evidence will be considered as well. Archeological research has become more and more interdisciplinary in the last decades and has seen considerable developments in the analysis of animal and plant remains. The results of archaeozoological and archeobotanical studies have consequently been invaluable to this study, the main problem being that many reports were never published or are not accessible.

\textsuperscript{73} Another series of orders has been preserved for Gibraltar, which, in the same way as the Dutch garrison of Namur, had a special role as an isolated outpost in foreign territory. Berkovich, 'Discipline and Control'.

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Current landscapes are in themselves also crucial source of evidence because they retain traces of past influences, 'scars' in the words of Braudel. Caution is advised, however, because there is often little that is authentic about medieval-looking structures in the Meuse Region. Many walls and castles have been reconstructed or restored in the nineteenth and twentieth century, but with what degree of accuracy is often unclear.

Because of these wide geographical and chronological limits, incorporating examples of the different areas of the Meuse Region throughout the main text has proven to be nearly impossible. Differences within the Meuse Region are an integral part of the argument, and will be given due attention, but constantly referring to distinctions within the Meuse Region even when this is of limited relevance to the argument, would have turned this thesis into a work the size of Braudel's magnum opus. The text instead focuses on a select number of examples, which can thus be properly contextualised. Further references are provided in the footnotes to avoid the impression that one example represents the whole Meuse Region.

1.6 Thesis Outline

The main argument, which is that armies' conscious and concerted conservation of ecosystems long predates the rise of modern environmentalism, and that this supposedly modern behaviour is just one element in a complex web of interconnections between armies and ecological systems, will be demonstrated through five chapters: frontiers, fortifications, disturbances, policing, and army health. These chapters represent the three levels encompassed within the ecosystem concept and, as argued before, constitute a more practical framework than ecosystem. The chapters follow logically as the thesis starts with the largest ecological level and follows up with lower levels. At the same time, they all refer to and need each other as a basis.

The first two chapters, frontiers and fortifications, represent the landscape level. The chapter about frontiers connects the ecological influences of military domains, which constitute such an important part of current military forces' discourse, to much older practices of security against external threats. It examines how significant military training practices were within larger processes of frontier management, and whether medieval perceptions of frontier continued to influence armies' actions in later centuries. The next chapter, fortifications, analyses the current emphasis on abandoned defences as safe havens for endangered plants and animals. Ruined buildings overgrown with plants might fit well a romantic idea of nature, but say little about to what extent present biodiversity levels are based on historical management practices. Discussions about former fortifications as cultural
heritage or ecological sites would benefit from a more thorough understanding of the ecological value of these structures when armed forces still managed them.

The third and fourth chapters, on disturbances and policing, examine biotic communities, or fauna and flora. They embody two seemingly antagonistic influences: damage and protection, both of which figure prominently in recent debates about the 'environmental footprint' of military forces. The chapter about disturbances investigates whether the most obvious or spectacular devastations, such as sieges or other large-scale interventions, were also the most meaningful in a long-term perspective. Warfare obviously involved the killing of humans, animals and plants, but one should keep in mind that ecosystems consist of transfers of energy. Theoretically, for every species negatively affected, there could be another taking advantage. Furthermore, armed forces might have exerted lesser-known influences that were far more destructive in the long run. The policing chapter places the current depiction of modern military forces as 'nature's army' in a broader historical context. Soldiers have a crucial role in the protection of endangered animals such as elephants or rhinos, but this behaviour might not be as progressive, or modern, as is often claimed. These are conflicts over control of natural resources, and the socio-economic value that they represent. Given that armies act as agents of both order and disorder, the use of armed force could very well have become a necessity because of soldiers' own actions.

The fifth chapter, on army health, focuses on the lowest level within the ecosystem concept: pathogens. Histories of military medicine traditionally construct a narrative of gradual progress, from medieval armies as epidemic hazards, over early modern attempts to impose basic hygiene, to the spread of modern medical theories in the nineteenth century. The last chapter questions this teleological paradigm by drawing attention to prophylactic health measures, or disease prevention, rather than the well-known emphasis on hospitals, surgeons, and wound treatment. It also considers historical examples of biological warfare, or deliberate attempts to spread disease, a major ethical problem that eventually started the debate on the ecological influences of the military.

Drawing these together, the general conclusion returns to the thesis' main argument, and emphasizes the significant role of historical armed forces in the protection and conservation of ecological systems. It also determines the main characteristics of army-ecosystem interactions in the Meuse Region from the thirteenth to the nineteenth century, and makes some final remarks about the relevance of these findings for current ecological conservation and future research.