

# atlas

Journal of Dublin University Geographical Society



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# Atlas

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# Atlas

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## Acknowledgements

*Rachel Gallagher*

*Atlas* is an academic journal of the Dublin University Geographical Society. It is a deeply rooted tradition of the society. Last year it was revived after five years of not being published. *Atlas* would not have got underway this year without the help of a number of people, whom I wish to thank.

Firstly I would like to thank all those who submitted essays to *Atlas*. I am delighted to say that demand this year was huge but unfortunately not all applications could be accepted.

I am proud to present this year's volume of *Atlas*, of which could not have been created without the help of my publication team. I would like to thank Evan Carey, Sadhbh Nic Giolla Chomhaill and Eoin O'Sullivan for all their great work in the past few months. I'd also like to thank this year's honorary president, Dr. Kevin Loughheed. His help in the society throughout the year was greatly appreciated.

I would like to thank Luke Scully, former head editor of *Atlas* Volume 13. He has been a great help in the whole publication process. His help and advice was valued greatly.

Finally, I'd like to thank the TCD Association and Trust for their financial assistance in covering printing costs in full. Without which, this volume of *Atlas* would never have gotten underway. I'd like to express the sincere gratitude of the Geographical Society to the Alumni of Trinity College Dublin who donated to this generous fund.



Hope you enjoy reading!

# Atlas

## **Foreword**

*Dr. Kevin Loughheed*

Dear all,

First of all, let me thank you for picking up the latest edition of the DU Geographical Society's journal Atlas. I am excited for this edition as it is full of excellent work. Atlas is something I look upon with pride and take a great amount of inspiration from. There are very few societies in the college, and indeed few geographical societies in the country, that produce their own journal. The fact that the journal is exclusively produced by the students, who are members of the society, makes it very unique. Atlas also holds a special place in my heart. As far back as 2007 (I am fighting the urge to say 'back in my day') I was involved in co-editing an edition of Atlas as a student (yes, I was a student once). I also had an article that analysed the arguments around the possible introduction of congestion charging in Dublin. While my article may have not changed that world (yet... here's still hoping), I still hold those events as being some of the most formative and influential in my becoming an academic. I will never forget it was GeogSoc who gave me the chance to not only have an article published in an academic journal as an undergraduate, but also gain the experience of editing other articles and seeing how a journal is published. As a result, every year the first thing I look for in the GeogSoc is any information around Atlas. In this regard, I would like to personally thank Rachel Gallagher for her extensive effort in making sure that there was an edition in the year that I was honorary president. So all that is left for me to say is thank you to all those students involved in this year's edition, either in submitting articles or in producing the journal, and I have no doubt that Atlas is in safe hands for many years to come. Enjoy, Kev.

## **Greetings from GeogSoc!**

### GeogSoc Committee 2015/16

The year started off brilliantly with over a hundred and seventy members signing up to GeogSoc in Freshers' Week. During the week, we ran a competition to be in with the chance of winning lifetime membership, won by Aisling O'Boyle.

At the beginning of October, we held an EGM and elected Megan to be our first year representative. In mid-October the GeogSoc library was reopened. Every Monday from 1-2 current librarian, Rachel, opened the library. This year the GeogSoc library has been a major success, with record numbers of students attending each week to enjoy the tea, coffee and biscuits provided. The 'Green Mile Pub Crawl' also took place in October. It was a successful night welcoming the incoming first years into the society

Geo Week ran from 16th- 22nd November. This years theme was 'Exploring the Power of Maps'. #GeoWeek2015. It was an extremely successful event, that went on to feature in the University Times. The week started off with a geography themed games night, named the 'Geolympics'. On Wednesday, to celebrate International G.I.S. Day, we had a talk "The Power of Geospatial Technology". This talk was presented by Ian Hand, from Mallon Technology, on remote sensing in GIS, along with our very own Dr. Kevin Lougheed. To conclude the week, a talk given by Dr. Annaleigh Margey and Dr. Mark Hennessey on "Maps and Memory; Decoding Historical Maps". This was followed by a food and wine reception, provided by the Department of Geography. A competition, 'Where in the World?', was held throughout the week, for students to guess the location of an aerial photograph. The prize of an Earth Ball ticket was won by second year Rachel Skelly.

GeogSoc is well known for its unique international field trips, with this years group of forty students traveling to



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Bratislava. At Columbius University the group went to a special lecture and city tour with Dr. Aleana Rochovska and her colleague Marcus. Following discussions surrounding Slovakian post-socialist development we walked along the River Danube, contrasting wealthy gentrified housing developments with homeless encampments to highlight urban development and social policy failures in Bratislava since the fall of communism. We visited Bratislava Castle, the Slavín Monument, St. Michael's Gate, the City Museum and other city landmarks; sipped cocktails in the iconic viewing station of the 'UFO Bridge'; and partied in an abandoned military bunker underground. On a day trip to Vienna we visited St. Stephen's Cathedral, Hofburg Palace, and passed by the Houses of Parliament, Vienna Opera House, the National Museum and the Christmas markets.

The annual Christmas Pub Quiz, took place at the end of the Michaelmas term in J.W. Sweetman. Students from all years and a number of staff from the Department of Geography participated. The quiz was narrowly won by a team of senior sophister students by a single point. The night also saw the introduction of the GeogSoc Christmas raffle.

The first event of the new year was Geographica: 2016 held in Sinnot's. This saw a record number of first years present. In late February, Earth Ball 2016 was held. It was hosted in the O'Callaghan Alexander hotel, where over one hundred students attended. An EGM was held to fill the position of chairperson after Denise's resignation in late January. Evan Cunningham was elected to work as acting chair for the remainder of the semester, Eoin O'Sullivan was voted in as new PRO and Vanisha Finlay was voted in as new OCM.

It has been a successful year for GeogSoc. The AGM will be held to elect the committee for 2016/ 2017. See you next year!

GeogSoc Committee 15/16

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*This edition of Atlas is dedicated to Dr. Andrew MacLaran and Prof. Michael Quigley, two former members of the Department of Geography. On behalf of all geography students, we would like to thank you for all your hard work over the past number of years.*

## **Urban History of Maynooth: Using the Irish Historical Town Atlas Series**

*Evan Cunningham*

### Introduction

The history of urbanisation in Ireland is long and varied. However, Irish history has shown evidence of a loose trend in which its urban growth has followed. Throughout the country, there are numerous forms of urban settlement with vastly different origins; ranging from pagan times right up to modern Ireland. The development of these settlements have been driven and shaped by wider processes; both geographical and historical. One way to examine this is to study in detail the growth and urbanisation of a particular town. This essay explores the town of Maynooth and its origins established. This essay will also explore the numerous factors affecting its topographical development over the centuries. This will be achieved through study of the Irish Historical Town Atlas of Maynooth, along with a range of other resources. This essay will also account for the wider political and social processes that influenced the urbanisation of Maynooth, as well as comparing the urbanisation of Maynooth to other towns in Ireland.

Maynooth comes from the Irish *Maigh Nuad Had*, meaning “plain of Nuadha”. Maigh Nuad is the modern spelling. Nuadha was one of the Gods of the ancient Irish, corresponding to Nudd of Wales and Nodens of ancient Britain and Gaul (Horner, 1995). Maynooth is located in north county Kildare, about twenty-four kilometres west of Dublin. The proximity to Dublin and other towns has had a huge impact on the urbanisation of Maynooth over the centuries. Maynooth is six kilometres north of the River Liffey. The Grand Canal runs through the south of the town. The River Rye also runs through the town; its important location will be discussed later on in this

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essay. One factor that has had a major influence on the urbanisation and growth of Maynooth are the Fitzgeralds. They were Normans who controlled the town and its surrounding countryside for centuries. This essay will explore the topographical development of Maynooth, which was influenced by the Fitzgeralds. A unique factor that has influenced the development of Maynooth is St. Patrick's University, opened by the King in 1795, this was the first Roman Catholic training university in Ireland. For a town the size of Maynooth, with a population of only a few thousand, the opening of a university is quite surprising. This essay will look at why the university was located in Maynooth and what wider political, economical and social process influenced this.

### Early Christian and Pre-Norman Development

The origins of Maynooth have been quite hard to pin down. The town was truly conceived after the Norman invasion of Ireland when Richard De Clare granted the area around Maigh Nuad to Maurice Fitzgerald in 1176. He proceeded to build a castle in the town; something that will be explored in more detail later on. However, before this there were signs of some small monastic settlements from the early Christian periods. They included Tagahode, located two kilometres south, and Donaghmore, located two kilometres east. The settlement closest to the town was called Laraghbryan. It was believed to have been built by St. Seenan in the sixth century. It is located about a kilometre south of the current town of Maynooth (Cullen, 1995). The fact that the three settlements were within a few kilometres radius of each other, it could be thought that these settlements might have had an influence on the origin of Maynooth. It can be seen that other towns, such as Bandon and Dundalk, also had monastic settlements located a kilometre and two kilometres from the town before the town was founded (Clarke and Gearty, 2013). These monasteries

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would have been a hub of medicine, defense and education, which would have drawn people to the locate there.

It has been speculated by Horner (1995) that with the evidence of the monasteries it showed that the area was territorially divided before the arrival of the Normans. With the conjunction of the River Rye and Lyreen, which met about eight hundred metres away from Laraghbryan, there was a strong possibility that a previous defensive settlement was located in Maynooth before the Norman invasion. It can be seen that the conjunction of the rivers would have been an excellent point to defend. Therefore, it would be the location of the future castle. Throughout the rest of Ireland at this time, the development of Irish towns and settlements had occurred in isolation from the rest of Europe. This was down to the absence of a Roman conquest of Ireland. The absence of Roman influence is quite clear, especially when compared to other European towns. Irish towns developed from early Christian periods without proper roads or buildings. The layout of Irish towns remained quite primitive before external European influence (Hughes, 1959). This all changed in the ninth century with the arrival of the Vikings. However, the Viking invasion of Ireland completely bypassed Maynooth. This would have impacted what type of settlement Maynooth would have become. Although there is a known Viking presence in the area, preserved through the nearby town of Leixlip. Leixlip was a known Viking name and means 'Salmon Leap'.

Although this does not feature in the literature, a possible explanation for the late settlement of Maynooth could be explained by the prominence and size of nearby villages and settlements. Firstly, Naas, only fifteen kilometres south of Maynooth, had been an important settlement since the ninth century, where the Kings of Leinster used to meet. Secondly, Trim, only twenty kilometres away, had an important monastic settlement, built by St. Patrick in the fourth century. Finally, Dublin was an important town at the time and had been

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prominent since the ninth century. Due to the importance of these settlements, both socially and economically, it could be thought that their influence meant that people were not attracted to Maynooth before the Norman invasion.

### Late Medieval Era

With the Norman invasion of Ireland in the twelfth century, Maynooth was truly born. The first wave of Norman invaders landed in Ireland in 1169. After the Normans had conquered the east coast, the Earl of Pembroke; Strongbow; granted land, including the Manor of Maynooth, to Maurice Fitzgerald. After being granted the land, the Fitzgeralds set to work building a large stone castle. A settlement growing up around a castle to serve and profit from its needs is a familiar pattern in Irish town development, which can also be observed in Kildare town. It can be thought that this is how the village of Maynooth first appeared (Cullen, 1995). The castle gave a settlement a key economic hub. The function of the castle was to also to defend against Irish rebels from attacking the settlement and lands. This explains why the stone castle was located at the west end of Maynooth, at the important bridging point of the River Rye and Lyreen. This was the ideal defensive point as it protected the town's vulnerable areas; it controlled the crossing of the river and was on the western edge of the town where any attack would come from. There can be little else observed after the building of the chapel on the grounds of the castle in 1248 and after the Fitzgeralds asked the Archbishop of Dublin to accept the chapel into the prebend of St. Patrick's Cathedral (Horner, 1995). A building of a chapel signified a growing settlement around the castle. In other Norman settlements, if there was a previous monastic settlement the Normans would not destroy it. Instead, they would take it over and let it continue to operate. There is no account for any such thing happening to Laraghbryan in Maynooth. This could suggest that the settlement was of little

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importance. In 1286, a weekly market every Friday and an annual fair in September was granted by Edward I (Horner, 1995). The granting of the market shows that Maynooth was slowly growing as a village. However, there was still very little difference between it and other small settlements.

During the thirteenth century, the influence of the Fitzgeralds grew and by the end of the twelfth century they served as the King's Chief Governor in Ireland. In 1316, the Fitzgeralds became the Earls of Kildare. Although it had minor impact on the growth at time, it would become an important development.

### Fifteenth Century

Towards the end of the fourteenth century, the Earls of Kildare along with their cousins, the Desmonds, emerged as the most powerful Anglo-Irish families of the time. The power of the Fitzgeralds led to Maynooth Castle becoming one of the most important castles in Ireland as it was the principal residence of the Earls (Cullen, 1995). This led to the growth of the castle. John Fitzgerald, the sixth earl of Kildare, built new offices and two gates, one of which led to the town. The enlargement of the castle also coincided with the Gaelic Irish fighting back against the English advances in Connaught and the Midlands. The enlargement of the castle, provided confidence and assurance to the townspeople that they were safe. During the late fifteenth and early sixteenth century the power of the Earls was at its greatest (Horner, 1995). This was down to the Hundred Years' War between England and France. The English had no time to deal with the unrest in Ireland and instead sought help from the powerful Anglo-Norman Lords, of which were the Fitzgeralds. The Anglo-Normans got on much better with the Gaelic Irish than the English and were in some cases 'More Irish than the Irish themselves'. This led to Thomas Fitzgerald becoming Lord deputy in 1471. His son, Garret Mor, then governed Ireland in the name of the King from

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1487 until his death in 1513 when his son, Garret Og, became Earl (Cullen, 1995). The heyday of the castle was in the early 1500s, due to the power of the Earls and their allegiance to the English. Unlike other Anglo-Normans in Ireland, this saw the granting of a license from the King to establish the College of the Blessed Virgin Mary in 1515, located beside the grounds of the castle. It can be thought that the building of the college illuminates the importance of Maynooth at the time to not only the Anglo-Normans but to the English as well.

### Sixteenth Century

At the start of the sixteenth century, Ireland becomes victim of a widespread Tudor conquest. Consequently, this led to a transformation of Ireland, from Lordship to a Kingdom, and we see the rejuvenation of British power across Ireland. As a result, this had a direct impact on Maynooth. At the beginning of his reign, Henry VIII was Lord of Ireland but in fact had little power or control of Ireland. The area he controlled was really confined to a small area around Dublin, referred to as 'The Pale', and to a few towns on the coast. Elsewhere, power was held by old Irish families or the Anglo-Irish, such as the Fitzgeralds of Kildare. The English were not happy with the power the Lords had in Ireland, such as the Fitzgeralds, and wanted to bring control of these lands into the power of the central government (Hughes, 1959).

The ninth Earl of Kildare was summoned to London and dismissed as deputy and replaced by William Silkington. On hearing this, Silken Thomas, the Earl of Kildare's son, led a rebellion against King Henry VIII in 1534. Silken Thomas led an army of one hundred and twenty horsemen to Dublin and renounced his allegiance to the King (McCorristine, 1997). Maynooth then became the centre point of the rebellion. Lord Thomas then proceeded to fortify the castle strongly and then went to seek reinforcements. Over the course of the following winter there was little response from either side, with some



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minor castles taken by each sides near the border of Kildare and Dublin. The rebels attacked both Trim and Dunboyne, proving that Thomas and his rebels were far from neutralised. They were not enough to get the English to come to the table and certainly not enough to make Skeffington or Henry VIII reconsider their presence in Ireland (McCorristine, 1997).

In March 1535, the English forces besieged the castle. Skeffington, who led the English forces, positioned his artillery to the north of the River Lyreen on the north side of the castle (Cullen, 1995). The castle was taken after nine days and suffered severe damage from the first reported use of gunpowder in history, doing particularly bad damage to the northern wall (Lewis, 1839). This incident ended the rebellion and stunted the growth of Maynooth. Consequently, it was no longer an important town or one of the central points of power in Ireland at the time. It could be thought that had Maynooth not fallen and had Thomas revolution worked, it is possible that Maynooth, a key point of the rebellion, could have become the de facto capital of Ireland at the time. It was also home to the Fitzgeralds, which would have seen huge urban growth in the town and could have even become a town the size of Dublin.

Another important aspect of this time was the Pale. The Pale was an area on the east coast that was controlled directly by England. It stretched from its most northern town of Dundalk to its southern point of Ballymore Eustace in Kildare. The Pale was first formed in the 1400s. As Maynooth was on the western edge of the Pale, it became a frontier town. As a frontier town, it was suspect to frequent attack from the Gaelic Irish. This was akin to other Irish towns, such as Naas and Kildare which also experienced this. The towns in the Pale began to take on a few distinctive features. One such feature was a barracks, located south of the castle on the south west side of the town (Horner, 1995). It became heavily garrisoned with English troops, such as Naas. As Maynooth was at the western edge of the Pale and subject to frequent attack from the

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west, could have played a pivotal role in the town growing to the east and north as there was no defence from the attacks if anything was built west of the castle.

### Seventeenth Century

At the dawn of the seventeenth century the Irish urban landscape takes a new shape. The Nine Years' War ended in 1603 and James I, the new king of England's, power extends to all of Ireland. Plantations began with the claiming of Catholic owned land. Many new towns are founded in different waves of plantations, which include Bandon, Derry and Portlaoise. There are also visible innovations from the British Empire now imposing themselves within Irish towns. One thing that becomes increasingly important and rife in most Irish towns is the presence of a market. This is due to increased trade from England. Maynooth is no different and we see the first signs of it as a market town in the early 1600s, where it is granted a license in 1674 to hold a weekly market. The development of the market square is in line with many other Irish towns; where the market is in the centre of the town, on the main street. In Maynooth, the market is located on the south side of the main street. This would have influenced the growth of the town to now be centred on the market, as it was where people traded and brought money into the town. We can see from Roques' map, the earliest map available, that any growth which took place in Maynooth centred around the main street. This has occurred in many Irish towns, such as Kildare.

Another major event that occurred in Maynooth in the seventeenth century was the remodeling of Maynooth Castle by Richard Boyle, the Earl of Cork. Boyle was one of the most influential men in Ireland during the seventeenth century. In 1630, he became father in law of George Fitzgerald and immediately set about repairing the castle, which he stated was totally ruined and ready to fall. Boyle's repair of Maynooth Castle was greatly influenced by his previous work at Lismore

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Castle previously. In 1635, the refurbishment and enlargement was completed. However, just seven years later when the Civil War broke out in England, the castle was soon in ruins again and would never be liveable (Cullen, 1995).

### Eighteenth Century

The eighteenth century brought about continuing Protestant ascendancy as well as the newly emerging phenomenon of agricultural and to an extent industrial economic activity in the first half of the century which were the main influences on the extensive topographical expansion of Irish towns during this century. As the British Empire stamps its authority on the landscape, symbols of the imperial power, such as jails and courthouses, begin to emerge in towns (Lydon, 1998). Extensive industrial development, such as that in Britain, bypassed most Irish towns, with the exception of a handful of towns in Ulster. The remainder of Irish towns continued to mostly market locally, with the exception of some commodity exports to Britain. Maynooth was no different, with the only recorded industry was the two mills located by the Lyreen River.

Another feature of this time was the return of the landlord; the nineteenth Earl of Kildare who set about making Carton House his new residence. Carton House was situated to the east of the town and was preceded by a tree lined avenue. The new Carton House was built to the design of German Richard Cassels, who had become one of the leading architects of the time. He built other country houses, such as Powerscourt and Russborough in Wicklow and Summerhill in Meath (Cullen, 1995). The return of the Fitzgeralds to Maynooth marked a new trend in the town and the town saw a spark in development. One of the main features was the remodeling of main street in 1750; before it was a haphazard layout with no pattern. The new layout led westwards from the old castle directly onto the tree lined avenue, leading to Carton House

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(Prunty and Clarke, 2011). This was a show of power by the Earl as it let residents know where the power lay. In the 1760s, there was a wave of creating estate villages. This can be put down to a number of influences. Rentals had been buoyant since the depressed 1740s, giving landlords more discretionary capital and awareness that a strong market town accelerated the economic development of their estates. There was also now a change of taste toward informal town landscape styles, which favoured the ready made 'romanticism' of the countryside (Aalen et al, 2011). The cumulative of these changes, led to a topographical effect on the location of estate villages, with villages now appearing further and further west. Maynooth and Monasterevin, in Kildare, only saw cosmetic modeling, for example remodelling of the main street. As with the other towns there was always an energetic engineer as the driving force in the change and Maynooth was no different with Peter Bere influencing the remodel. It can be thought that the change in layout in Maynooth benefitted the town as it became more organised and allowed the town to grow from the main street out, like many other Irish towns.

The benefits of the new dawn in innovation from the British, did not pass Ireland by entirely with many towns benefiting from transport improvements, such as railways and canals, which is evident in Maynooth. The Royal Canal, which was opened in 1796, flows through the south of Maynooth town. The Duke of Leinster; Earl of Kildare; who was a subscriber of the canal company, commissioned the building of a harbour on the canal. Unlike other towns where the canal flowed through, there was no economic benefit of the harbour as there was no industry of note in Maynooth at the time. This highlights the power the Duke commanded at this period. The canal had no impact on the development of Maynooth, with not one store being built at the harbour (Aalen et al, 2011). Horner argues that it did actually influence the town in the nineteenth century when the Great Western Railway was built on its route.

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It can be thought that the modern day connectivity the railway provides Maynooth with Dublin, has a considerable impact on the growth of the town.

Towns continued to grow in tandem with their improved economies, whether industrial or not. As population multiplied rapidly, so too did towns topographically, with the sprawling of housing beyond original town perimeters becoming commonplace (Lydon, 1998). Between 1793 and 1815, in order to meet accommodation needs for a long war between England and France, a barrack building programme took place in towns, such as Armagh, Bandon, Belfast, Derry and Dundalk. This was in order to accommodate seventy thousand soldiers. In Maynooth, there was a temporary barracks built to the south of the castle. This can also be seen in Downpatrick.

### Nineteenth Century

The nineteenth century brought further innovation to Ireland as well as more wealth. Dublin was now the second city of the British Empire, which was an important factor. The location of Dublin to Maynooth had perhaps its greatest influence in the 1800s. A major impact on Maynooth at this time, was what Clarke and Gearty refer to as the coaching complex. From as early as 1717, we see the first records of coaches from Dublin to Kinnegad. This developed to a significant business in the 1700s with Kildare, Armagh and Downpatrick all on coaching routes; people had to be fed and horses changed. From the 1700s, Maynooth was on the route west from Dublin. With improved road surfaces, there was a huge increase in traffic. Maynooth then became the first place for coaches to be changed on the route west. To take advantage of this, the Leinster Arms Inn was established in 1770. It was on the south side of Main Street beside market square. With a continued increase in travellers, the inn became the Leinster Arms Hotel in 1822. This also happened in Longford and

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Armagh, when their inns became hotels in 1802 and 1828 respectively. The growth from an inn to a hotel would have witnessed more stores opening on main street in Maynooth to cater for the coaches.

Perhaps the most unique aspect of Maynooth is its university. St Patrick's University, founded in 1795, was the site for a new Roman Catholic college. It is located to the south west of the town, just off Main Street and beside Maynooth Castle. The choice of Maynooth as the location for the college comes down to the Duke of Leinster who greatly encouraged the Grattan Parliament to build the new site there. The university is the single biggest topographical feature of Maynooth and has influenced major growth of Maynooth, with the town growing around the college in order to cater for the students studying there (Horner, 1995). We see this in later maps, which document the growth of Maynooth to the north and to the south west, something which had not happened before in Maynooth's history. Similar patterns of growth can be seen at many other universities. Coleraine, in Northern Ireland, grew into a significant town after a university was built in the 1960s and evidently the same has happened in Maynooth.

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Map 1: Showing Maynooth in 1821 (Irish Historical Town Atlas, No.7 Maynooth, 1995)



Map 2: Showing Maynooth in 1940 and its Growth to North and South West (Irish Historical Town Atlas, No.7 Maynooth, 1995).

## Conclusion

Over the last thousand years, the town of Maynooth has been shaped by many wider processes. The influence the Norman invasion of Ireland has had over the growth of Maynooth is monumental. The power of the Fitzgeralds dominated the topographical development of Maynooth. Any growth in Maynooth over the last hundreds of years, has mostly been an outcome of the influence of the Earls of Kildare on the town. By building a stone castle and Carton House, the Fitzgerald's footprint on Maynooth has been present for centuries and the impacts of which continue to affect the growth of the town. The town of Maynooth is today a university town and is most commonly known by the presence of the university, which was only built due to the Fitzgeralds. Although, to this day Maynooth remains a small town. This could be put down to the location of Maynooth with regards to other major towns. The fact Dublin, which has been the economic centre of Ireland for centuries now, is so close to Maynooth could possibly have stunted the geographical growth of Maynooth. It could also be thought that the topographical layout of the town, with regards to the castle and the main street meant that all growth that took place in Maynooth was centralised there. When it comes to comparing Maynooth to other towns in Ireland, it becomes quite tricky due to the history of Maynooth. Perhaps the most comparable towns would be its near neighbours, Trim and Naas, who inherit the same factors and characteristics of urban growth as Maynooth. Although its origins are quite recent compared to other Irish towns, Maynooth has changed multiple times over the years on the type of town it is, which is something that all Irish towns have done in the past; from a defensive town to a market town, from an estate town and to a coach town. Maynooth has adapted to the wider social and economic process that have changed the town over the last few centuries and continues to thrive as a small town today.



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## **Did The Northern Plains of Mars Contain a Warm Ocean?**

*Rob Halpin*

### Introduction

This essay will discuss whether the theorised large standing body of warm water existed on Mars in early history or not. As no definitive answer can be given to the question of whether an ocean existed on Mars, the approach taken will be to compare and contrast various scientific papers and articles to compile facts and create arguments for and against the existence of the hypothesized ocean. The definition of a warm ocean in this work will be taken as a large body of water (in liquid form) that exists at 0°C or more.

Mars has two very contrasting hemispheres. The Southern highlands are highly cratered and cover approximately 66% of the planet's surface. This region is also pockmarked with volcanoes like those seen in the Tharsis bulge. The volcanoes in this area include the highest volcano in the solar system (Olympus Mons) and the largest (Alba Mons). Also observed in the highlands are valley network systems which are thought to date back to the planet's heavy bombardment phase 3.5-3.8Gya (Forget et al, 2013). These theorised outflow channels are one of the main pieces of evidence used in supporting the possibility of a large body of water on the planet (Williams et al, 2000).

The Northern hemisphere, however, is made of flat and smooth lowlands, and is separated from the highlands by a boundary known as the Martian dichotomy. It has been suggested that "the northern lowlands may have contained a large standing body of water in earlier Mars history (Parker et al, 1989). It is thought that the existence of the northern lowlands is due to one giant impact, or lots of smaller overlapped impacts (Wise et al, 1979; Frey and Schultz, 1988). Due

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to later resurfacing, however, any clear morphologic proof for its origin has been removed so the formation of the lowlands is also up for debate. Significantly better quality topographic mapping of the surface of the planet by the Mars Orbiter Laser Altimeter (MOLA) has shown that three large and enclosed basins exist within the Northern lowlands. These are called the Borealis, Utopia, and Isidis basins and could have contained long standing bodies of water (Tanaka et al, 2003). The highly contrasting nature of Mars's two hemispheres is unique to the planet and is not seen anywhere else in the solar system. This suggests that whether or not an ocean existed, some truly exceptional circumstances must have formed them.

The subject of whether or not a large amount of liquid water existed on Mars has become one of much debate. Our knowledge of the planet is constantly increasing due to Nasa missions such as the Mars Reconnaissance Orbiter (2005) and the Mars Curiosity rover, which has been active on the surface of the planet since 2012. These missions aim to examine landforms on the Martian surface, as well as carrying out an investigation of the climate, geology, the role of water and the potential for microbial life on the planet.

From the undertakings of Nasa and other space exploration programmes, we now have a much fuller picture of the planet as a whole. The Mars Odyssey Orbiter has given us many pictures of the planet's geomorphology, using its Thermal Emission Imaging System (THEMIS) and the Curiosity rover, (along with the rovers that came before) have given us a greater understanding of what the surface of the planet is made of, as well as what it looks like. What we've discovered, however, tends to create more questions than answer them.

There is a lot of observational evidence to support a large ocean in the Northern hemisphere of Mars. Observations seem to suggest a large amount of fluvial surface weathering on the planet more than 3.6 billion years ago (Carter et al,

2015), but water has been very limited (if existing at all) since this period (Tosca and Knoll, 2009). This includes deltaic deposits, which are the most significant landforms indicating the presence of long-term bodies of water on the planet's surface. Di Achille et al (2010) and many other studies argue that their analysis of the deltaic deposits “lends credence to the hypothesis that an ocean formed on early Mars as part of a global and active hydrosphere”.

Other evidence to support an active hydrosphere on early Mars includes (the previously mentioned) valley networks and present-day Martian topography. Caleb et al (2008) states that instead of an ocean in the Northern lowlands, there were “210 open-basin lakes fed by valley networks”. The study used present day topographical evidence to estimate the volume of water in each lake. Some of the volumes found were “comparable to the largest lakes and small seas on modern Earth, such as the Caspian Sea and Black Sea”, showing the vast amounts of water that could've existed on the planet, if these basins were in fact filled with liquid water. Similar studies have also been carried out to study the size and length of valley networks. Hynek and Phillips (2003) found a larger number of valleys, longer total valley length and drainage density in the Southern highlands than was previously estimated. From this it was concluded that surface runoff was probable during the time period of the valleys and therefore precipitation was also a key factor in shaping a large amount of the Martian landscape in early Mars history. If precipitation occurring during the early history of the planet was in liquid form, then it could be assumed that this precipitation would have pooled into bodies of water, such as the theorised ocean in the Northern lowlands.

Fairén et al (2003) also points out that their paleotopographic reconstruction of the Tharsis magmatic complex exposes the existence of an extremely large Noachian drainage basin and aquifer system in eastern Tharsis. “This basin is proposed to have sourced outburst floodwaters that

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sculpted the outflow channels, and ponded to form various hypothesized oceans, seas, and lakes episodically through time” (Fairén et al, 2003).

Furthermore, Martian gullies have been discovered in places like Newton Crater on the planet’s surface. The appearance of these gullies could suggest that liquid water created them. “Some scientists hypothesize that liquid water burst out from underground, eroded the gullies, and pooled at the bottom of this crater as it froze and evaporated” (Nasa, 2000). This theory, however, is highly disputed as it is also possible to form the gullies in numerous different ways. Dundas et al (2010) argues that the formation of some of the newer gully features are caused by “dry granular flow with no volatile involvement” at all, and that seasonal activity seen in their creation is also “consistent with proposed models for gully formation driven by CO<sub>2</sub> frost”.

Additionally, as Mars is very different to Earth, it is possible for the geomorphology seen on the surface to have been created in completely different circumstances, even though they look extremely similar to those found on Earth. Equifinality is the principle that the same end state can be reached by many different potential means. This is a large issue when studying observational evidence for an ocean on Mars. The deltaic features, valley networks and gullies on the planet may look like those carved out by liquid water on Earth, but that may not necessarily be the case. Other processes have been suggested for the formation of the Northern lowlands on Mars. Rather than the basin being shaped by sedimentary infilling from an ocean, Tanaka et al (2003) have suggested that the lowland’s history is instead, composed of “broad, episodic erosion and modification of volatile-rich material and local to regional sedimentary and volcanic infilling”. This theory is one agreed upon by other research such as that carried out by Carr and Head (2003). Tanaka et al (2003) further state “Geomorphologic evidence for a northernplains-filling ocean is

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absent because one did not form or its evidence was destroyed by resurfacing”.

Another argument against liquid water on Mars in any form is the current conditions on the planet. For water to exist in its liquid form on the surface, a much thicker atmosphere and warmer climate than what currently exists today would be needed (Read and Lewis, 2004). The current atmosphere of Mars is “about 100 times thinner than Earth's, and has an annual mean temperature of approximately  $-60^{\circ}\text{C}$ ” (Sharp, 2012). With its thin atmosphere and greater distance from the sun (than Earth), it is not possible for liquid water to exist on the surface. In fact, if liquid water was transported to the surface of the planet, it would “instantly freeze or boil, depending on the local combination of temperature and pressure” (Nasa, 2000).

Many studies of Mars's paleo climate have been undertaken and most still can't recreate the conditions necessary for a large body of water to exist on the planet. Older research papers such as Pollack et al's (1987) paper used a 1 dimensional climate model to find that Mars would need 5bar pressure and CO<sub>2</sub> rich atmosphere to result in  $0^{\circ}\text{C}$  annual mean temperature, allowing water to exist on the surface. At higher pressures, however, CO<sub>2</sub> condenses into ice clouds in the middle atmosphere. This was once thought to have caused warming due to the scattering greenhouse effect of these clouds. The ice clouds however, would actually raise Mars's planetary albedo, reducing the net warming effect. Forget et al (2012) discovered from their 3D climate model that even if parameters that maximize the warming effect are assumed, the mean annual temperature cannot increase by more than +15K. This still comes up a long way short of a warm and wet climate. The research inevitably came to the conclusion “that a CO<sub>2</sub> atmosphere could not have raised the annual mean temperature above  $0^{\circ}\text{C}$  anywhere on the planet” (Forget et al, 2012). Meaning that regular water could not have existed in liquid form on the planet and no ocean could have formed.

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This raises an issue between the observational and theoretical evidence for a large body of water on Mars. Many papers, such as Timothy et al (1989) propose that “Geological evidence (e.g. small valley networks and outflow channels) strongly suggest an extensive role of liquid water” on the planet, yet from our limited knowledge of the planet’s paleoclimate, we cannot recreate the conditions necessary for it to exist. This definitely does not mean it can be definitively said that there was no ocean on Mars, but instead points out how limited our knowledge of the planet’s past is. Climate models have come a long way from the original one dimensional design, but even the most recent models struggle to deal with the faint early sun hypothesis (Haberle, 1998).

Another portion of the argument for a large standing body of water comes from erosional features along the dichotomy boundary, which is hypothesised to be the ancient shoreline for the ocean if it existed. There are many observed erosional features in these regions, but there are no depositional features, which would also be expected in an area near a shoreline. Out of 447 THEMIS and 735 MOC NA images inspected as part of Ghatan Zimbelman’s (2006) study, “only four candidates are observed that are plausibly interpreted as coastal ridges; no candidate coastal ridges are observed in the MOLA profiles”. This is an extremely low amount. Only 0.34% of the images studied show evidence for a long standing body of water. Tanaka (1997) also argues that the shoreline thought to have been created in association to channel activity, actually post-dates outflow channels and therefore may not have been created by the same processes that carved the channels. Furthermore, it is claimed that the contact in places actually bares resemblance to a lobate deposit which occurs in the upslope direction, rather than a paleo shoreline. Other morphological features which were previously understood to be terraces created by stillstands from a retreating ocean, may

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instead be contractional tectonic features (Thomson and Head, 2001).

A large revelation in the debate of whether or not there was an ocean on Mars was the recent discovery by Nasa of possible evidence for liquid water on Mars. Dark streaks have been observed on slopes when temperatures rise above  $-23^{\circ}\text{C}$  on the planet (Brown and Cantillo, 2015). It has been theorised that this is proof of salty/briny ice melting and becoming liquid under the surface. This is due to the fact that saline or acidic solutions of water can be liquid at temperatures much lower than zero degrees Celsius.

The current mean annual temperature for Mars is approximately  $-60^{\circ}\text{C}$  (Sharp, 2012), and even under these extremely low temperatures, it is now thought that melting on the surface occurs for a few days in the warm seasons every year. This opens up the possibility that if there was an ocean in the Northern hemisphere during early Martian history, that it could have been briny water. This could explain how the ocean remained liquid even under the extremely low annual temps that are predicted from current climate models such as Fastook et al (2012) and Forget et al (2013).

### Conclusion

In conclusion, based on the current evidence, it is unlikely that a warm ocean in the Northern lowlands of Mars existed. Though there is a lot of observational evidence which could support a large body of water, such as the valley networks and deltaic landforms (Caleb et al, 2008; Di Achille et al, 2010), these could be described as different landforms or explained by different processes, such as those styled by Tanaka et al (2003) and Carr and Head (2003). When this information is coupled with the fact that we don't currently have a reliable climate model which explains how a large body of water could be sustained on the planet, it must be concluded that there is little definitive evidence for the theorised ocean at any time in



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Martian history. Although the arguments outlined above underline the unlikelihood of a hypothesised ocean, no undisputable theory can be put forward until new information comes to light or further research is carried out.

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**“Governance has a critical role to play in co-ordinating ... disparate voices and securing collective action to achieve a more sustainable future” (Evans, 2012). Discuss.**

*Liam Sweetman*

A global problem requires a collective solution. In a globalised world of rapidly growing population, the pressure on the environment to provide for its inhabitants has been fast approaching the point of no return. A sustainable future relies on a total U-turn before this point of demand outstripping supply is reached, and thus hinges on the collaborative management of Earth's natural resources.

Hardin's (1968) parable of the commons highlights the disastrous impacts unchecked human access can have on natural resources. The reckless abuse of resources does not stem from insidiousness, rather it is simply human rationale to maximise yields of what is freely available. In Hardin's commons, anarchy results in the over-exploitation of public goods and a future barren of resources (ibid). The role of governance thus, is to check human nature and 'steer society towards collective goals' (Baker, 2006, p.9). It is needed both as a mediator and a regulator to ensure the sustainable use of Earth's resources.

As environmental degradation and unsustainable practices operate at multiple scales and irrespective of international jurisdiction, governance efforts too must be multi-level and far reaching. It is clear that sporadic, isolated efforts at local levels will not be sufficient for a global reversal of the ongoing environmental crisis. A common need of individuals is to consume resources necessary for survival, while the common goal is to ensure consumption is sustainable and fairly distributed (Sherman, 2005). Different actors across the world are vying for their own consumption, equality of distribution and sustainability. These disparate voices are co-ordinated via

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scalar co-operation and the establishment of agencies or institutions of national and international supremacy which aim to amalgamate them towards a unified stance. From this co-ordination global goals emerge and their message can be redistributed across the world. Further to this responsibility, governing measures attempt to then encourage the mechanisms of change: a diverse array of actors from local, to government level or interest groups to implement policies geared towards these goals. There is no one conclusive means of resource management, rather it is a combination of top down initiation and application of scale-independent networks which are inherent in any real world successes.

A look to governance in practice at different scales of authority will shed light on how convening measures must operate within and across boundaries, through hierarchical and network systems.

### Global Initiation: Awareness raising and guideline setting

The actions carried out in the realm of international politics in recent decades have been crucial to resource sustainability's recognition as a global responsibility. As a more interconnected world community, a platform has developed where unilateral efforts can be made to steer the international community towards governing for a sustainable future.

The first major steps towards a global co-ordination came at the United Nations with the Brundtland Report. This stage was adroitly used in framing the call for governance as necessary factor in global development. Significantly, this report was not merely a scolding of perpetrators of environmental damage, instead it called on all actors within the global sphere to work towards a new development model. Baker (2006: 25) notes the significance of this report in 'linking environmental degradation with economic, social and political factors and presenting sustainable development as a model of

social change.’ As a result came the Rio Earth Summit and subsequent bodies and agreements such as Agenda 21. From this the collective goal of resource-use reform and sustainable development gained currency among national authorities and the public. Though gaining a lot of attention on the world stage, criticism has been levelled at these institutions for talking a great talk but themselves implementing few direct measures on the ground (Sherman, 2005). However, to view efforts at this scale to be a total failure would be to misinterpret the aims of global level governance.

In a vast world of disparate communities; a concrete, functional system of policy-enforcing hierarchical governance straight from the top down was never truly feasible. Instead, global efforts must be assessed as instigative; in terms of raising awareness, policy drafting and making environmental governance a priority at national and more localised levels. The following cases will show how, without explicitly governing policy on the ground itself, the descending policy from higher scales is often the catalyst for generating policy and implementation at more localised scales.

### Supranational Governance: The EU as a microcosm for global trends of hierarchical instigation and networked implementation

As environmental degradation occurs trans-boundary, EU policy operates in kind. Policy is made with a collective goal with the emphasis on shared costs and shared benefits (Connelly et al, 2012; Evans, 2012). Broadly speaking, the EU operates a hierarchical system of governance, generating environmental directives at Parliament and Council level, and fiscally incentivises their implementation at domestic level across the 27 member states. With its roots as an economic community, European policy consistently acts with the marketability of sustainability in mind.



The EU Emissions Trading Scheme, effective in 2005, was a unilateral agreement across the member states which created a carbon market (Connelly et al, 2012). Set amounts of tradable emissions allowances were allocated to energy-intensive businesses in the context of an overall EU capped figure. While companies emitting below their allowance sell their credits to profit, those exceeding their granted emissions invoke compulsory purchase orders of others' surplus credits or heavy financial punishment. Inevitably, resistant voices emerged among traditional non-renewable industries and the economies which relied upon them. The successful ratification of the ETS despite this opposition serves as an example of where a multitude of actors operate collaboratively in a network of different functions to achieve policy implementation among a myriad of opposition. Advocacy was the determining factor as NGOs, low emission industries set to benefit from credits and Green parties within governments (particularly in the German coalition of the time) leaned their weight towards the efforts of the pro-scheme UK and Danish governments and forced the legislation through (ibid).

Interlinked with carbon reduction is the EU's efforts in the provision of alternative, sustainable energy sources. Coming together in a similar fashion to the ETS has been the green certificate and fiscal scheme on renewable energy in Europe. The hesitancy towards renewable energy stems from the costs incurring in overhauling a sector so heavily reliant on traditional fossil fuel resource exploitation (Sherman, 2005). Yet after initial investment, renewables provide by far the most cost-effective means of energy provision (EREC, 2010). In pushing tentative actors towards the change-over, the EU again acted like a micro-model for the flow of governance; vertically passing down policy while incentivising its implementation through horizontally operating networks. As part of Union-wide sustainable efforts, the European Renewable Energy Council has been critical in co-ordinating member states and

the actors within them in creating the infrastructure for a European energy policy based on renewable energy sources. By fiscally incentivising domestic actors in member states and non-state energy corporations, the EREC has added momentum to the push towards wind energy in Europe. Despite the immediate costs associated with wind turbine construction (€2.5 million per 2 MegaWatt turbine), state and non-state actors have come to understand the long term profitability of wind energy (EREC, 2010). The resultant opportunities have led to the aggressive pursuit of exploiting wind turbine technology by vertically-integrated power producers, increasing participation of utilities as businesses and international energy providers collectively get involved in the industry (ibid).

### Domestic Application: Intra-state bodies and the knock-on implications of regional measures

It has been theorised by Roberts (2011), among others, that environmental management has moved from ‘Government to governance’. Baker (2006, p.76) too notes how ‘Environmental governance is no longer coterminous with a delimited political territory, nor is it seen as the exclusive business of governments’. Yet examination of the processes which operate at national level suggests that the state very much has an important role in the evolved operation of environmental governance. With the downward flow of guiding policies from international spheres, the state itself has adopted an advanced, co-ordinator approach in which it combines multi-faceted co-operation, expert consultation and market planning to make reform genuinely viable. The key to success here is that the benefits of domestically constructed networks make an easy transition cross border, particularly in a regional context.

At times a visible, functioning success can be the catalyst in steering others to reform. Heres and Lin (2011) – note the success of measures taken in California to reduce

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greenhouse gas emissions and increase the states' usage share of renewable energy sources, which even spread across to other states. In the wake of the signing into law of Assembly Bill 32 [The California Global Warming Solutions Act], the state government set up a Climate Action Team tasked with reducing carbon emissions by 80 percent below 1990 levels by 2050. In efforts to ensure collective input into a collective task, this action team consisted of representatives of 17 state agencies and non-state actors, while 'the general public and stakeholders actively participated in the development of the final scoping plan through public meetings, workshops and responding to solicitation for ideas' (ibid, p555). From this extensive and open dialogue carefully considered measures were implemented to ensure the people of California collectively moved towards reduced emissions and a sustainable future. Carbon taxing, in the form of permits, and new building regulations reduced allowance for energy inefficiency and non-renewable usage. From this taxes revenue has been raised for grant assistance in retro-fitting and providing old buildings with solar panels and geothermal systems where compatible. The biggest impact however, came from the new regulations introduced straight to manufacturers on vehicle emissions and home appliance efficiency standards.

Given the dominant market size of California, regional suppliers had no choice but to phase out the production of inefficient models and overhaul all their products to meet these new requirements. With many of these industries operating along the west coast of the US, neighbouring states came to be supplied with the same, 'green' appliances and vehicles by happenstance as the whole market supply evolved. Furthermore, on foot of California's success and with a convenient influx of more energy efficient products, neighbouring states such as Oregon and Nevada have followed suit and adopted similar emission reducing measures. Just as the costs of resource damage are collective, so too can be the

knock-on benefits of successes when networks secure cross-border collective action.

### Transnational Advocacy Networks in Co-ordinating Governance at Local Level

In tandem with playing referential roles in policy-making within the domestic framework, non-state actors arguably operate best by means of network governance systems. Citing the localised, issue-by-issue lobbying and grassroots efforts of Friends of the Earth, Roberts (2011) highlights how NGOs can operate across and between both states and scales of authority. It is with the freedom of a non-authoritative role that network approaches can achieve a more fluid access to solidifying compliance across scales.

A more in-depth analysis of network governance can be seen in the International Council for Local Environmental Initiatives (ICLEI) 'The Cities for Climate Protection Program (CCP)'. Diverse geographically, culturally and linguistically, cities are a prime example of beneficiaries of a co-ordinative effort in international governance. The CCP allows participant cities to speak as one unified voice, engaging in 'global advocacy, co-ordinating responses between local governments at UN climate change negotiations' (Connelly et al, 2012, p.375).

The guiding role of global actors is seen again here, with the project forming as a response to the UNFCCC agreement signed in at The Rio earth summit. Though the foundations were global, the ICLEI operates on the thesis that a collaboration of local efforts can solve a global problem (Bulkeley, 2005). As worldwide urbanisation develops cities into major hubs of resource consumption and waste emission, the initiative's CCP recognises that a sustainable future will have to support a mass urban population worldwide. Operating transnationally and in relative freedom from their respective overlooking domestic institutions, member local authorities

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operate software to profile urban emissions, raise awareness and facilitate dialogue through workshops with politicians and civil servants, and can contribute to local land and waste management policies (ibid). As local governors, the authorities are not hampered by the scalar distance and context irregularity problems global actors face. The ability of network groups to transfer collective global ideals to disparate localities allows for legitimate and expert governing by those closest to the ground.

### Conclusion

Undoubtedly, governance is critical as a global solution to a collective problem. An anarchical world is one with a short lifespan. It is only through global co-operation that the tragedy of unrestricted human access to common goods that the environment provides can be overcome. In assessment of how this management of resources can be successful, hierarchical and network governance systems should not be seen as mutually exclusive for both are key mechanisms in the ongoing struggle towards a sustainable future. As is evident in the above examples, hierarchical systems facilitate the trickle-down of co-operative dialogue, collective goals and draft policies from the global stage on which they are played out to supranational, national and local levels. Working off these guidelines, network governance effectively operates within and across states to co-ordinate and adapt approaches to their suitability of the context at hand. Ultimately, it is via the governance of scales which disparate voices are co-ordinated, and the operation of diverse actors transcending scales which work to actually secure collective action.

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## **Tropical Environmental Management Report: The Mangrove Swamps of Bangladesh**

*Ellen Cunningham*

### i) Description of the environmental context:

Mangroves are intertidal forested wetlands confined to the tropics and subtropical regions (Tomlinson, 1986). They can often undergo physiological and structural adaptations to their habitat influenced by saline and tidal inundation (Hossain et al., 2014). They have the ability to migrate landward or seaward in relation to sea level transgression and regression respectively (Heit and Behling, 2009). Unlike other mangrove forests, the mangroves of Bangladesh, commonly known as the Sundarbans, takes the form of a mosaic of islands that vary in shape and size, rather than the more commonly zoned formation of other mangrove forests around the world (Islam and Tooley, 1999). The Sundarbans is the world's largest coastal wetland, comprising over 10,000km<sup>2</sup> and is located in the delta of the rivers Ganges, Brahmaputra and Meghna, with 60% of its territory lying in Bangladesh and 40% in India. In Bangladesh, it is located in the SW corner of the country, within Khulna and extending over parts of Satkhira and Bagherat. As recently as 200 years ago its territory extended farther inland covering nearly all of Khulna. (Iftekhar and Islam, 2004). Due to its deltaic location, the rivers carry vast quantities of sediment, contributing to the expansion and contraction of the region (Gaupal and Chauhan, 2006). The Sundarbans occupy a coastal belt with dimensions of about 175km in length and 60km in width (Islam and Tooley, 1999). The area of mangrove swamp in Bangladesh is low lying, varying between .9 and 2.1m above Mean Sea Level, making it a high risk area to the effects of sea level rise (Iftekhar and Islam, 2004).

The Bangladesh Sundarbans Reserve Forest (SRF) is composed of three wildlife sanctuaries established in 1977



under the Bangladesh Wildlife Preservation Amendment Act and this area was extended in 1996 (UNESCO). The SRF is the source of livelihoods for a high local population density with over 3.5 million inhabitants within and around the forest boundary. It consists of a number of complex creeks and rivulets which control the balance between fresh and saline water in this highly diverse region. Freshwater dominates during monsoon season, while levels of salinity are at their highest in the dry seasons after monsoons (Agrawala et al., 2003). These mangrove swamps support intensely diverse flora and fauna and are home to many endemic species, including the Bengal tiger. Because of the dominance of saline conditions, the forest flora in the western Sundarbans is not as diverse as the east (UNESCO).

Bangladesh has a warm, humid, tropical climate that is influenced primarily by monsoon and partly by pre-monsoon and post-monsoon circulations. The south-west monsoon originates over the Indian Ocean and carries warm, moist unstable air. Easterly trade winds are also active providing warm but somewhat drier circulation. The country experiences four prominent seasons: Winter (December to February), Pre-monsoon (March to May), Monsoon season (June to October) and post-monsoon (late October to November). About 80% of all annual rainfall occurs during these heavy monsoon seasons. (Agrawala et al., 2003). The Sundarban area experiences an annual rainfall of 1600-1800mm and very severe cyclonic storms (Gaupal and Chauhan, 2006). The mangrove swamps are vital to the local population of as they acts as a buffer zone to major cyclonic storms in the area. Temperature varies from about 37 to 11°C and rainfall increases from west to east. The soil of the mangrove swamps is of recent origin and consists of alluvium washed down from the Himalayan orogeny. Surface geology consists of quaternary sediments, sand and silt with marine silt and clay layers. (Iftekhar and Islam, 2004).

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Reconstruction of the Holocene paleoclimate in central Bangladesh has been done in relation to relative sea level changes 200m north of the present coastline by using lithofacies, mangal peat, diatoms and physiological evidence. (Rashid et al., 2013). Another study was done in 2009 of a 50m core taken from the western Ganges-Brahmaputra delta (Heit and Behling). Mangrove pollen can be used as a sea level indicator as they are extremely sensitive to any sea level changes. Holocene vegetation and environmental history in this area has been poorly understood in the past and is vital for the understanding future mangrove dynamics and development so management can be implemented. (Heit and Behling, 2009). Because of the mangroves sensitivity to sea level and salinity changes, its expansion, contraction and movement can be tracked throughout the Holocene in studies like the ones I have just mentioned. In coastal areas, mangal peat formation is favoured by stable sea level rise. However, this rise must not be too slow or too rapid, implying that peat beds are formed under stable sea level conditions (Rashid et al., 2013).

Varying transgressions and regressions of sea level throughout the Holocene have been identified on the coast of Bangladesh and this corresponds with disappearance and reappearance of the mangrove ecosystems. (Heit and Behling, 2009 and Rashid et al.,2013). According to Rashid et al, at the peak of the LGM (18,000 years ago), the Bengal lowland experienced dry climatic conditions and sea level was approximately 100m lower than present, as large amounts of freshwater were trapped in the form of glaciers. At 12ka, the SW monsoon became prominent causing intense rainstorms and subsequent rapidly rising sea level. This intense precipitation plus glacial melt from the Himalayas caused a high relative sea level. The presence of the Indian summer monsoon during the early to middle Holocene was generally stronger than today and peaks have been identified at 8500ka, 6000ka and 2700ka. In general, during the mid-Holocene it is

estimated that sea level was slightly higher, climate was warmer and rivers discharged up to 2.5 times more sediment (Rashid et al.,2013) and diverse mangrove environments have been identified during the early Holocene by the variation in pollen assemblages from around 9880ka (Heit and Behling, 2009).

The loss of intertidal habitat due to the accumulation of vast amounts of sediment from sea level regression, as well as high rate of fluvial sedimentation from Himalayan orogeny triggered mangrove disappearance due to an imbalance between freshwater and salt water sources. This balance is essential for the success of mangrove populations (Rashid et al.,2013; Heit and Behling, 2009). It is suggested that a this balance was present in the Late Holocene due to the presence of two distinct mangrove species that prefer to grow in areas with sufficient freshwater levels. (Heit and Behling, 2009). Recently, this balance between freshwater and salinity has been disturbed due to sea level rise and the diversion of freshwater by humans (Gaupal and Chauhan, 2006).

### ii) Explanation of current and future environmental challenges:

Mangrove plant species can be divided into three different categories based on their tolerance to salinity: freshwater thriving, moderate saline thriving and saltwater thriving. Due to increased salinity in the Sundarbans of Bangladesh in the last 100 years, salt tolerant species have been expanding and gradually displacing freshwater species. This increase in salinity occurred when the intake-mouths of rivers such as the Mathalanaga and the Kobadak, became silted up, as these rivers were large carriers of freshwater to the southern part of the country. The freshwater stocks were further depleted to the area when India constructed the Farraka dam on the Ganges river in 1975, 17km upstream of the Bangladesh border. The flora and fauna of the mangrove eco-system are dependent on a balance between saline and fresh water and this

disturbance has been a challenge to the surrounding area. (Islam and Gnauck, 2009). The regulation of river flow for human needs have has a negative impact on the biodiversity of the mangrove swamps as species distribution varies with salinity (Gopal and Chauhan, 2006) and a reduction in freshwater availability has made way for a range of socio-economic problems in the area.

The single most important mangrove plant species is known as *Heritiera fomes* and this crop is the most dominant, covering 52.7% of the area. (Iftekhar and Islam, 2004). However, top dying disease of *H.fomes*, which is associated with increased water salinity is one of the most serious diseases of the Sundarbans of Bangladesh as this species is vital in the regions timber industry. (Islam and Gnauck, 2009). Around 20.18 million *H.fomes* trees, covering 198.5km<sup>2</sup> are severely affected by the disease. This spread of disease has the potential to be catastrophic to the area, as over 80% of the income generated in the Sundarbans comes from wood (Islam and Gnauck, 2009). Over foresting due to the increased demands of the ever growing population density of the area has also contributed to the massive losses of this mangrove plant species for saw timber and fuel, with *H.fomes* depleting by 40% since 1959 (Iftekhar and Islam, 2004). Forestry is an extremely important industry in Bangladesh, and the Sundarbans forest area contributes about 50% of the revenue in this sector (Islam and Gnauck, 2009).

The clearance of vast areas of mangroves for shrimp aquaculture in the South Eastern Chakaria Sundarbans in 1982 which was patronised by the “Asian Development Bank” has led to rapid deforestation, leading to increased sedimentation and discharge load of nearby rivers. Shrimp farming also encourages farmers to artificially inundate lands with brackish water during periods of low salinity, causing obvious damage to forest cover. (Agrawala et al., 2003). Degradation of mangrove forest cover has led to the increased vulnerability of

the area to cyclones and tidal waves. (Islam and Waheb, 2006). The unplanned development of coastal aquaculture in the mangrove swamps of Bangladesh has proved unsustainable both biologically and socio-economically and it is an industry that is continuously growing due to suitable agro-climatic conditions, cheap labour force, international donor agencies and the involvement of multinational corporations (Paul and Vogl, 2009). According to Islam and Wahab (2005), shrimp farming is the most destructive form of resource use in the mangroves of Bangladesh. In the Indian Sundarbans, most of the destruction occurred before the rise of the shrimp industry and is therefore attributed mostly to agricultural expansion, but in Bangladesh, mangrove swamps are still being converted to ponds for shrimp aquaculture (Paul and Vogl, 2009). Massive clearance of large areas of mangroves has resulted in reduction of natural production of fish and shrimp larvae that use mangrove for feeding, breeding, and nursery grounds and has therefore led to the abandonment of farms as stocks became insufficient (Islam and Wahab, 2005).

Some of the most significant future challenges to Bangladesh's mangrove swamps will be caused by sea level rise. According to the Rio+20 National Report on Sustainable Development, experts predict that 15% of the Sundarbans will be lost due to sea level rise in the next few decades, endangering an ecosystem that is already fragile due to deforestation, over exploitation by humans, reduced water flow from the Ganges and top-dying of *H. formes* mangrove tree (2012). A sea level rise of 45cm would inundate 75% of the Sundarbans and a 67cm rise would inundate the whole system. A 25cm rise would result in 40% mangrove losses, and it is unlikely that the plants ability to migrate inland even if barriers were moved, would make up for losses due to sea level transgression (Agrawala et al., 2003). It is estimated that the total number of people that are directly employed by mangrove forest is between 500,000 to 600,000 for about 6 months of the

year. As well as this, around 120,000 tourists visit the area in peak season and 50,000 fisherman work in the waters on a daily basis (Islam and Gnauck, 2009).

An increased number of the population would be exposed to the dangers of cyclones, which are prevalent in this tropical area. It is estimated that a 100-200m wide mangrove belt reduces wave heights by 20-25% and the efficiency of mangrove protection belts in taming the impact of cyclones has been observed by the local population (Iftekhar and Islam, 2004). Not only would the destruction of mangroves due to sea level inundation cause major financial losses to the area and the county as a whole, but it would actually leave people more vulnerable to extreme weather, which is commonplace in the tropics. Seawater inundation would lead to further alteration of salinity patterns and it is estimated that the low-saline area would decrease from a base condition of 10.8% in 2001 to 4% in 2100 due to sea level rise. This increased salinity would also further contribute to the degradation of the already fragile *H.fomes* mangrove tree which I mentioned earlier, and it is estimated that by 2050, population of the species will have decreased by 14% and 45% by 2100 due to climate change induced sea level rise. (Uddin et al., 2013).

However, it is not only the people of Bangladesh that will suffer due to future climate change, this fragile ecosystem supports some of the most diverse flora and fauna in the world. The Sundarbans Reserve Forest (SRF) is home to 291 species of fish, 300 species of flora and 425 species of fauna, including the only wetland population of the Royal Bengal tiger (*Panthera tigris*). Further changing of the hydrological and floristic composition from salt water inundation would interfere with food chains and lead to gradual extinction of many endemic and fragile species (Uddin et al., 2013). Mangrove environments provide important nursery functions for juvenile fishes in terms of shelter and feeding, and the future deterioration of these

habitats would have a negative effect on local fish stocks and breeding seasons (Tse et al., 2008).

Oil exploration is a new threat to the area and in December 2014, as reported by National Geographic, an oil spill occurred upstream of the Sundarbans region of Bangladesh, inside the Chandpai dolphin sanctuary. The sanctuary is home to endemic species of dolphin including the Irrawaddy and the Gangetic dolphin. 52,000 gallons of oil leaked into the brackish water and spread throughout the area. This level of pollution could pose a massive threat to crustacean populations and other lifeforms in the area. The fact that the tankers were using the dolphin sanctuary as a passage begs the question of whether or not there is enough emphasis of the importance of the Sundarbans being put on the community and local industries (Alexander, 2014).

### iii) Recommendations for future management strategies:

The surrounding population is highly dependent on the Sundarbans Reserve Forest (SRF) for resources and income and as a result, the forest is suffering (Islam et al. 2013). In many places, the development of tourism depends on the preservation and protection of the natural environment, which in turn depends on the level of dependence of the local communities on it. Growth in the volume of foreign tourists to Bangladesh has generally been much slower than in East Asia and one of the main reasons suggested for this is the fact that virtually no local people are employed in the tourism industry in the Sundarbans, as well as the fact that tourism in the area is highly seasonal (Tisdell, 1997).

Community based conservation (CBC) approach to tourism has been adapted in many areas, such as South East Asia, as an alternate means of income to the local people, while also instilling the importance for conservation of the surrounding area (Islam et al., 2013). In a study by Islam et al., the attitudes of local people to the exploitation of the forest and

to the idea of CBT was investigated. By conducting face to face interviews, it was established that 80% were dependent on the natural resources of the forest and 54% admitted to collecting at least one forest product illegally, with the majority using fishing passes to illegally cut down wood, as wood extraction is currently prohibited in the forest. All 100% of the participants agreed that the forest was deteriorating in forest and aquatic health. CBT has the potential to reduce anthropogenic pressure on the forest by reducing the surrounding population's dependency on it, while also providing a further financial incentive to conservation. More than 70% of participants identified CBT as a tool that could play a role in future conversation. (Islam et al., 2013).

A vital aspect of the Sundarbans that must also be managed is the fishing industry. The SRF was declared as "reserve forest" in the late 1800s under the Forest Act of British India. Control of fishing is exercised by the Forest Department (FD) and fisheries resources are exploited on the basis of maximum sustainable yield, which is not compatible with sustainable management. No comprehensive fisheries management system has ever been implemented in the Sundarbans, and although the Asian Development Bank is currently supporting a biodiversity project, overfishing of certain species is still a problem of high intensity. The management of shrimp and other aquaculture by zonation, more sustainable production practices and protection of wildlife is recommended for conservation while still providing the industry as a source of sustainable income to local communities (Hoq, 2007).

According to Islam and Waheb (2006), the Government of Bangladesh needs to implement guidelines for brackish water aquaculture, especially in areas of shrimp culture and farms must provide specification on all aspects of farming including types and amounts of chemicals that can be used, effluent discharge, import of shrimp fry and catching of fry



from wild populations. It is also recommended that destruction of mangroves for shrimp farms must be banned. A policy which implements these guidelines would ensure institutional supervision and encourage sustainable income for the local population. By decreasing the intense pressure that the current aquaculture sector is putting on the mangrove swamps, the inundation of saline conditions may also be reduced due to regulation of production practices. (Islam and Waheb, 2006).

The mangrove swamps of Bangladesh are a lucrative resource environmentally, socio-economically and financially. The surrounding population are extremely dependent on the mangrove regions and the forests themselves have suffered in both qualitative and quantitative terms. (Islam et al., 2013). The ecosystems natural balance has been disturbed from overfishing, deforestation and anthropogenic factors such as climate change induced sea level rise (Raha et al., 2012). The climatic history of the region illustrates the sensitivity of mangrove swamps to sea level transgressions and regressions (Heit and Behling 2009; Rashid et al 2013) and thus highlights the potentially devastating effects of anthropogenic sea level rise on these highly dynamic areas. The deltaic location of the Sundarbans and its already fragile state, has left the mangroves and its inhabitants extremely vulnerable to sea level rise and degradation (Raha et al., 2012) and the further removal of this buffer zone could be catastrophic in the future (Iftekhar and Islam, 2004). Increase of downstream salinity due to the Farraka dam has had detrimental effects to vital mangrove plant species and biodiversity (Islam and Gnauck, 2009). However, although the Sundarbans of Bangladesh has been declared a World Heritage Site and a Ramsar site (UNESCO), there is a need for more guidelines to be implemented on aquaculture regarding the conservation of current fish stocks and the clearance of mangrove trees for shrimp farms should be banned completely (Islam and Wahab, 2006). The Sundarbans potential for community based tourism should be recognised.

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An alternate source of income is necessary for the surrounding population of the mangrove swamps and has the potential to reduce the local populations' dependency on the forest, thus allowing it to replenish itself and allowing the community to become involved in the conservation of their own most valuable resource (Islam et al., 2013).

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## **Examining Gender Roles and Responsibilities that have Formulated as a Consequence of Water Scarcity.**

*Rachel Nevins*

### Introduction

Water scarcity has been defined by the UN as the point at which the aggregate impact of all users encroaches on the quantity or quality of water under dominant institutional arrangements, to the extent that the demand by all sectors, for example, the environment, or agriculture, cannot be wholly satisfied. Mehta states that ‘real scarcity is relative to several hydrological, meteorological, agricultural factors’ (2003), and is heavily associated with the extremes of social inequality. Indeed, fresh water is a renewable yet, finite resource, and the appropriate management of this store is essential. Postal confirms that there are now several signs that human water use exceeds sustainable levels (2000). The ruinous effects of water scarcity will truly materialize by 2025, as the UN predicts that 1.8 billion people, a third of the world’s population, will have absolute water scarcity, and another two thirds of the world’s population will be living under extreme water stress. These catastrophic figures display the vast geography of the problem, however it is imperative to note that while water scarcity is a world-wide problem, it has become extensive within the most vulnerable communities on Earth, the developing world.

The access to a safe and sustainable water source is deeply correlated to climate change, variability, disasters and conflicts (United Nations Development Programme, 2014). However, women living in the developing world undoubtedly bear the brunt of the consequences of the mismanagement of water resources, at a domestic level. Women are less likely to adapt to fluctuating access to water sources, and have less means and capacity to adjust to climate variability. This results

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in a disproportional level of responsibility placed on the woman: rural mothers, grandmothers and their daughters perpetually take exclusive responsibility for providing water to the family and for family health (Hemson, 2000). While women and girls are responsible for collecting and organising water for domestic purposes, men are involved in the development and management of water at a national level. This separation leads to deeply ingrained inequalities between men and women's work load, time consumed by water related activities and responsibilities of providing fresh water for the family or community. Through examining gender roles and responsibilities, policies and programmes can be established that eliminate the imbalance between women and men in both water management and environmental sustainability. These initiatives are imperative to the provision of safe drinking water throughout the world. Consequently, this essay will discuss and examine the gender roles and responsibilities that have formulated as a response to water scarcity.

### Water Supply on a National Scale

Water resources demand a high level of management, at both a domestic level and a national level, as growing concerns over water security is prominent danger to many countries. The Water Security Risk Index specifies eighteen countries worldwide are at 'extreme risk' of danger due to instable water security (Shevah, 2014). Fifteen of these specified countries are situated in the Middle East, where water resources are inadequate and unequally distributed over time and geographical space. As previously stated, traditionally, the management of the finite resource is controlled on a national level by men, while the task of domestic management is delegated to the women of the household. Regardless of the blatant inequality seen in the distribution of managerial power, the maladministration of water resources in the developing world is a hinder to the development of the nation as a whole.

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In regards to the critical water scarcity problem in India, Bandyopadhyay expressed that in order to guarantee the stability of development and the overall wellbeing of the people, 'the new water plan will have to address ecological issues and equality of access' (1989). In addition, Bandyopadhyay emphasised the importance of distinguishing drought from man-made scarcity, and urges administrations to delve deeper into an ecological examination of drought and water scarcity. This rapid depletion of water sources and the water scarcity that results, consequently endorses the commodification of water. Hughes states that the international water industry defines water as a private good to be extracted and traded on free markets, outside of state ownership and government regulation (2009). As increasing pressure to commodity the resource amalgamates, the conception and the value of water is transformed; 'When you start to think like we think, you don't see water in the pipes. You see dollar signs', Eric Berliner. It is now extremely important to implement preventative legislation, policies and programmes that protect those most vulnerable to water scarcity ensuring the fair distribution of safe water, before the complete endorsement of commodification occurs.

It is vital to note that depleting rainfall is not merely the solitary reason for decreasing water supply, as 'disrupted water cycles can turn water from an abundant renewable resource into a vanishing non-renewable resource', (Bandyopadhyay, 1989). This is a concept that can be seen world-wide, as instable water cycles threaten water supplies. However, calculating the actually demand and supply of water is an extremely difficult task, with Simmons claiming that demand induces the presupposing of particular levels of delivery, quality and price: all of which are highlighted as fluctuating elements (1991). Unquestionably, when demand overrides supply, a shortage is bound to occur, leaving supplies scarce. Simmons continues on by stating that 'local and



regional availabilities are paramount in spite of heroic efforts in some countries to dam, pump and pipe on a large scale' (1991) thus the access to fresh, clean water in nations is heavily dependent on locally climatic supplied surpluses of precipitation over evaporation, or local levels of evapotranspiration. The access to freshwater also vacillates due to population densities, with Falkenmark commenting that 'population growth is of course one crucial component behind the accelerating water scarcity' (1989), and results in the long term generation of extraordinary susceptibility amongst communities.

Indisputably, water management at a macro level has a contagion effect on the supply of water at a micro level. As previously stated, calculating the precise the supply and demand for water sources is an incredibly difficult task to undertake, leading to the mismanagement of water resources. This can consequentially cause the undersupply of water resource either nationally, or domestically.

### The Irrigation Issue

In order to combat the scarcity of water on a national level, irrigation schemes are often implemented. Irrigation, the artificial supply of water, has been seen as a saving grace for many farmers and arable workers, who otherwise would have been at the mercy of sparse water supplies. The importance of efficient irrigation schemes is essential to the food supply of the world, as Pulido-Velazquez and Ward estimated that 60% of added food required will come from irrigation (2008). However, Pulido-Velazquez and Ward add that natural ecosystems have become adjusted to 'stream discharge, precipitation, and evaporation patterns' (2008) that are found in arid environments. Therefore, any major human alterations to the water cycle, such as irrigation schemes, can have largely complex results on both the economic and ecological systems. Fishman claims that it is imperative for farmers to be educated

in the better utilisation of rainwater, along with the effective precision of irrigation water (2011), as Pulido-Velazquez and Ward warn of the mounting pressure for irrigated agriculture to ‘produce more crop per drop’ (2008). There is widespread conception that as irrigation efficiency improves, more water resources would be made available for local communities, as irrigation often exploits groundwater. Bandyopadhyay explored the case of Indian arid environments and states that groundwater is the dominant source of domestic water (1989), further emphasising the toxic relationship between the national and domestic supply of water. Bandyopadhyay continues on to reaffirm that the extraction of groundwater via hand pumps is the primary source of drinking water, and urges the estimation of ‘the sustainable levels of exploitation’ (1989). Furthermore, it is vital to acknowledge that following the occurrence of acute meteorological drought, communities fall back on groundwater as their main resource. However, if irrigation source have fully exploited this source of water, communities are left with an extreme shortage of consumable water. Indeed, the inefficient use of irrigation water can have a ruinous effect on already depleting water sources. Fishman claims that farmer use twice the amount of water that all other uses combined, with 67% of the world’s water is allocated to agriculture (2011). Highlighting agriculture’s grossly disproportionate share of water resources, Mehta reaffirms that there is an extraordinarily vast inequality in the access and control of water resources, drawing on the juxtaposition of irrigation pumps working twenty-four hours a day, while poorer women are left with dry drinking wells in water scare Western India (2003). This lack of respect found amongst the farming communities for the instability of water resources must be addressed, with as much as half of the irrigation water going to waste (Fishman, 2011). Falkenmark urges the development of cooperation between farmer and local people, and encourages efforts central to the already existent adaptability of the local community,

‘improving and further developing existing local solutions’ (1989). In addition, Mehta claims that the local communities have attempted to strategically adapt to the lack of water that can result as a consequence of irrigation schemes; a task ingrained in local knowledge systems and practices, and mainly delegated to the women of the household. While a village with an abundance of wealth have a wide range of coping mechanisms, the poorer communities are left with dry wells and inadequate alternatives. In addition to the prevalent class differentiation, other social forms of disparity, in particular gender, can ‘legitimise unequal access and control over scarce resources’ (Mehta, 2003). In attempt to combat these issues of severe water scarcity, Postal encourages a willingness of professionals to cross both disciplinary boundaries and professional boundaries, and ‘for academics to join with practitioners’ (2000). Furthermore, it is vital to guarantee that water policies focus on the management of water as a whole and manage water resources at the lowest appropriate level, recognising women as a central player in the management of the resource (UNDP, 2006).

### Climate Justice

Not only must gender and social aspects alike be taken in consideration in the allocation of water resources, the concept of climate justice must be examined. Climate justice is defined by the Mary Robinson Foundation, Climate Justice (MRFCJ) as the linking of ‘human rights and development to achieve a human-centred approach, safeguarding the rights of the most vulnerable and sharing the burdens and benefits of climate change and its resolution equitably and fairly’. Climate justice aims to magnify the voice of the people who have done little to cause climate change, and investigate the unitary threats faced by the future generations. As climate change evokes a raise in temperature, a shift in precipitation patterns and the circulation of water, alongside the raising of sea levels and

increased flooding, it is becoming increasingly important to highlight the dire effects these changes will have on communities. As a result of poor management of the distribution of water resources preserves, many of those living in vulnerable communities are at high risk of contracting water borne illness, such as Botulism, Cholera and Dysentery. However, Robinson emphasises that the effect of climate change varies greatly from country to country (2014), a sentiment reinforced by Fishmen who boldly states that there is no global water crisis, but ‘a thousand water crises, each distinct’ (2011). Fishmen comments that all water issues are founded in locality and differ region by region (2011), therefore indigenous, provincial solutions must engendered to ensure the equal and fair distribution of water resources. Nevertheless, Robinson confirms that 99% of the climate change casualties occur in the developing world (2014), bringing the issue of climate justice into question. Less than 1% of the world’s greenhouse gas emissions that result in climate change is attributed to the fifty least developed nations in the world (Robinson, 2014), leading many researchers to examine the issue of common responsibility. This is juxtaposed to the opinion of Fishman, who remains true to the conception of the locality of water issues claiming that the region itself must formulate a solution for their own water scarcity issues. In a stark contradiction, Robinson urges the construction of a sense of common heritage; a sense of common concern of human kind that reflects the duty of states of equally sharing the encumbrance of environmental protection for common resources, such as water (2014). In addition, Falkenmark urges for the essential increase in awareness and change in the behaviour of more developed Northern nations (1989). These states should be encouraged to view themselves as ‘as listeners on the outside, present mainly to support local initiatives’ (Falkenmark, 1989). This is opposed to the past behavioural habits of northern states, which saw prescribed solutions and

answers being allotted onto regions with entirely different ecological and social conditions. Falkenmark comments on the failure of these ‘ready-made solutions’ (1989), using the example of the engineering solutions offered in the past to the Sahel region. A mere 10% of the two hundred and fifty projects assigned to the region since the 1970’s have persisted the withdrawal of expatriates.

If this commonly shared protection is to be established, one must recognise the women who constitute as the majority of the world’s poorest persons (Robinson, 2014), and who endure extreme sufferings at the hands of socially ingrained gender inequalities. These discriminations against women subsequently cause development gaps, which Robinson states results in a disproportionate amount of climate change effects being thrust upon the poorer women of developing nations. Indisputably, men and women are affected by climate change in gender specific ways, as a result of the gender roles placed upon on them, and the demands made by families and communities (Robinson, 2014). The need for a stronger gender perspective is highly evident, as Terry claims that ‘gender analysis should be integral to the appraisal of public policies’ (2009). Gender inequalities alone may motivate and encourage more women into leadership roles, and positioning a stance against climate change, however these governing roles must attend to the entire range of climate issues (Robinson, 2014). In addition, women in leadership roles must undertake the prodigious task of introducing a gender perspective to each of the issues they face. Robinson comments that while women are indeed adversely affected by the impacts of climate change, one must not overlook the powerful agent of changes they can become (2014)- women must tackle these issues at a global, national and community level.

### Gender Roles and Responsibilities

## Atlas

As previously stated, women experience the ruinous effects of climate change, such as water scarcity, in a vastly different manner to that of the man's experience, a direct consequence of the gender roles that have been placed upon the women. These gender roles have been strengthened and deepened in the societal and cultural understandings of many under developed and arid communities, as the women of the household is expected to acquire water for family's domestic use. This obligation adds a substantial amount of accountability on the women of the household, leading them to circumstantially prioritise the needs of other household members in particular the young, elderly or ill above their own. This can put the women at risk of dehydration, alongside other illness (Wutich, 2009). Moreover, the physical work necessary to acquire the water, for example as strenuous walks and transporting bales of water can have an adverse, harmful and destructive impact on the physical and mental state of the women, and can accumulate up to four hours a day. The economic cost of the time spent in water acquisition is a major form of time poverty and income loss, highlighted by a study completed in Bolivia. This examination emphasised that the time lost to water insecurity may result in a missed day's paid work, loss of sleep or the inability to tend to one's children (Wutich, 2009). These consequences are more often than not experienced by the woman of the household, however it can have a dire effect on the community as a whole. Bloom et al. commented that low levels of learning as a result of teacher absence may be a reason behind low student turnout in schools in the developing world (2007). Due to the gender roles imposed on the women of the developing world regarding water scarcity and security, the teacher presuming she is a woman with a family will more than likely prioritise water acquisition for her own household over her employment responsibilities. Thus, this further portrays the discriminating

and demeaning gender roles placed upon women in regards to water acquisition.

The inequality between men and women in terms of the responsibility of water acquisition for domestic use is vast, displaying the depth of the discrimination against the women of the communities, and highlighting the sexual division of labour. At its simplest form, sexual division of labour is defined as the allocation of particular types of work to particular kinds of people, fuelled by the lack of skill and training a particular type of person is conceived is have obtained (Connel, 1987). Connel states that the sexual division of labour within families and household displays traditional ideas about the 'women's place', relative to her husband's power (1989). However, it is imperative to note that gender does not simply refer to woman or man, indeed referring to the different rights, roles and responsibilities of men and women and the interactions between the two sexes (UNDP, 2006). In addition, gender inequality exists when men- or women enjoy an excessively large share of a valued good, such as political power or long life (Dorius & Firebaugh, 2010). This gender inequality is indisputably seen within water resource management, resulting in the UNDP formulating an aim to achieve integrated water management activities that ensure a gender neutral perspective, alongside gender mainstreaming (2014). By intertwining gender mainstreaming- the process of addressing the implications for women and men of any planned action, within water scarcity legislation and programmes, both women and men can benefit equally within societal and economic spheres. Without comprehending gender differences, inequalities within environmental sustainability will prevail, increasing the already prevalent imbalance.

Furthermore, it is vital to include women in policies regarding water administration, as they are central to the provision, management and safe guarding of the resource (UNDP, 2006). Currently, women face many gender specific

barriers that limit their ability to cope with and adapt to a changing climate (Terry, 2009), which can result in a lack of water security for households. Cannon et al. stated that the neglect of the gender dimensions of climate changes is anticipated and unsurprising, due to the 'stark fact that women as a group are poorer and less powerful than men' (2002). In order to remove these restraints on women, gender analysis must be undertaken. Without this form of data, planners depend on women assuming a central role in coping strategies in response to the effects of climate change, such as water scarcity. This assumption occurs without the realisation of the weight of the burden imposed on the women of the household, relying heavily on the women's unpaid labour (Cannon & et al, 2009). Furthermore, the assumption adopts the conception that women are 'naturally predisposed to serve their families or communities by protecting the environment on which they depend for livelihoods' (Cannon & et al, 2009), compartmentalising the woman into a state of being inside her own households. This reflects the main discourse that is occurring within the developing world, regarding the warfare against the effects of climate, such as water scarcity. This discourse is stereotypically masculine, detailing new technologies, large scale economic instruments, and complex computer modelling (Terry, 2009). This form of innovation seen within the men with societal power is evident across the globe, with Fishmen detailing a new wool washing processes adapted by those in those wool business in Adelaide, Australia. As opposed to utilising a mega litre of drinking water a day enough to sustain seven hundred and fifty families Fishmen noted that the producers now use urban runoff and storm water, known as 'purple-pipe water' (2011). These kinds of innovate advances are imperative to the equal distribution of water, however without the acknowledgement that the woman of the household as the central agent to water security, and subjecting



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strategies to gender budget scrutiny, the implementation of water policies will be short lived and unsuccessful.

In addition, one must acknowledge that very few women have been trained in the skills required to engage in detailed scientific debate regarding the impacts to climate change and water scarcity (Terry, 2009), as a result of the gender roles that has been imposed. This lack of skill has manifested in a sense of inexperience and unawareness, to the extent that at a recent Round Table on Gender and Climate Change hosted by the Institute of Development Studies and the Department for International Development, several participant expressed feelings of ignorance (Terry, 2009). In order to combat the gender roles imposed on women, and to discourage any feelings of ignorance in the term of climate change and water scarcity, women must be involved in an increased level of education. Bloom et al. state that in 2000, one sixth of the world's children of primary school age were not enrolled in school: more than half of these children were girls (2007). This portrays the deep inequality engrained within developing societies, and greatesn the woman's vulnerability due to a vastly limited access to resources. However, while women's vulnerability in the response to water security blatantly exceeds that of the man's, it is plausible to assume that men of the developing world also receive some adverse effects at the hands of gender roles and responsibilities. Cultural norms often result in situations where men experience gender-specific vulnerability, as well as women. Following this, Terry examines the incidence of the deaths of young West African men attempting to reach Europe by boat, which can be partly attributed to climate stress on rural livelihoods, forcing them to leave their communities and take fatal risks (2009). It seems that regardless of gender, cultural norms and societal influences navigate roles and responsibilities on a person that can result detrimentally ruinous consequences for the imposed.

## Conclusion

Incontestably, water has two imperatively fundamental functions which are in constant conflict; its role as a prerequisite for life, and its use as an economic resource. Postal states that this conflict is a challenge that ‘spans science, technology, policy, and politics’ (2000), and is one that requires a new way of attaining both commodity and ecosystem benefits, from the same volume of water. Water supply at a national level is considered to be the responsibility of the man of the household, while the women undertake water acquisition at a domestic level. Domestically, women face the daily challenge of competing with irrigation schemes, which run the local well and groundwater dry, whilst disrupting adaptive water cycles in arid environments. This interaction is blatantly unjust, and is an issue that innovative thinking, such as climate justice, should aim to overcome, through linking human rights and development to a human centred approach, safeguarding future generations from the threats faced today. Through this approach, gender roles and responsibilities that have formulated in response to water scarcity should be dissolved and detached, removing the unequal access to resources, and the unfair distribution of power. Indisputably, an astronomical amount of responsibility lies upon the women of the household in regards to water acquisition. While this effort should be commended, it is vital to the future adaptability and overall societal success of developing nations in the face of climate change and water scarcity to endorse the liberation of the woman, to allow her to be removed from gender roles and responsibilities, and to irreversibly separate her from the shackles of water tankers.

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# Atlas

A selection of DU Geographical Society photos from 2015/16



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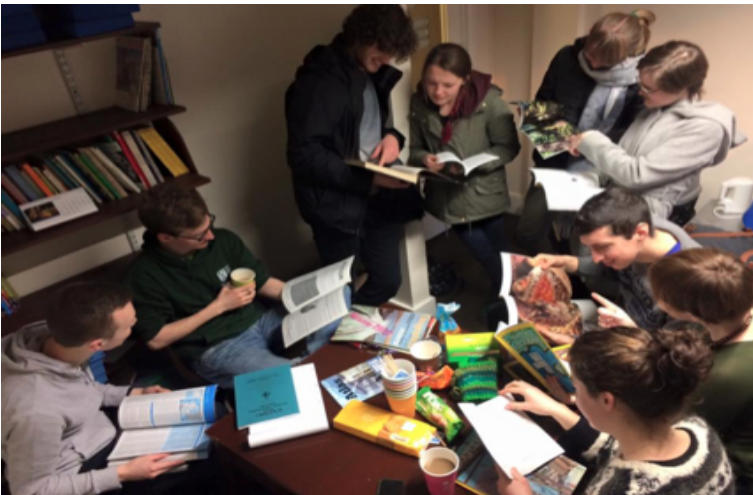
DU Geographical Society Committee members 2015/16



## Atlas



This years opening of the GeogSoc library, with librarian Rachel Gallagher. The library has had major success this year.



# Atlas

Geo Week: 16<sup>th</sup> - 22<sup>nd</sup> November



Geolympics Winners 2016!!!



# Atlas



GeoSoc's annual pub quiz, hosted by Ivan Loza.

# Atlas

## International field trip to Bratislava, Slovakia.



# Atlas



Columbus University, Bratislava, with Dr. Aleana Rochovska, her colleague Marcus and our fieldtrip coordinator Sadhbh.



# Atlas

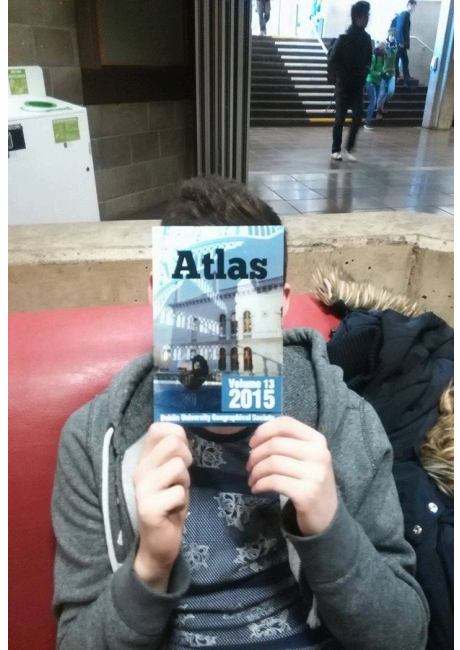
Earth Ball 2016- safe to say, we had a ball!



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