

# Climate Change: *Coastal Flood Threat*

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## Key takeaways

- The U.S. is not adequately prepared to deal with natural disasters.
- Climate change will make catastrophic disasters and flooding worse.
- The U.S. does not have a comprehensive approach to flood management and prevention, only focusing on disaster cleanup.
- The Netherlands is a global leader in flood management and can offer lessons for the U.S.

## Introduction

Climate Change presents a national security threat to the United States. Rising sea levels and more severe storms cause billions of dollars in economic damage and threaten coastal populations and infrastructure.

American flood control measures are inadequate to deal with this rising threat. Flood management is not harmonized and is underfunded. The National Committee on Levee Safety reported disturbing findings on shortcomings in the protection levels of levees, concluding that many communities live “at an unacceptably high risk.”<sup>1</sup>

The Netherlands is a global pioneer in flood control and management. The Dutch experience can offer lessons to the United States as it grapples with the rising cost of climate change.



## Coastal Flooding threatens the U.S

### Loss of life and property

- The costs of climate change for the United States continue to increase. Rising global temperatures bring more energetic storms, stronger storm surges, and increased flooding.
- The United States is increasingly being hit by natural disasters that have a high death toll, and severely disrupt economic and social activity. From 2000-2009, the federal government spent \$288.9 billion on hurricane relief, up from \$84.4 billion in the 1990's.<sup>2</sup>
- Two recent storms that were particularly severe are illustrative of the threat moving forward. Hurricane Sandy in 2012 killed 117 Americans<sup>3</sup> and caused \$70 billion in economic damage<sup>4</sup> and Hurricane Katrina killed 1,500 Americans<sup>5</sup> in 2005, and caused \$135 billion in total damage.<sup>6</sup>

### Flood risk exposure

Climate scientists estimate that the global average sea level will rise by three feet or more this century,<sup>7</sup> presenting serious threats to coastal communities. In New York, the sea level is projected to rise by 2 to 5 inches in the 2020s alone and 12 to 23 inches by the 2080s (not taking into account rapid ice-melting).<sup>8</sup> This presents a significant threat to people and property on the coast.

- Almost 50% of the U.S. population lives within 50 miles of the coastline;<sup>9</sup> 39% of the total population lives in counties directly on the shoreline,<sup>10</sup> and over 4.2 million homes along the coastline are threatened by storm-surge risk.<sup>11</sup>
- An estimated 16% of total U.S. property value is located in coastal counties at risk of flooding.<sup>12</sup>
- Insured U.S. property located in coastal counties exceeds \$10 trillion, with Florida and New York alone accounting for more almost \$3 trillion each.<sup>13</sup>

## National Flood Insurance Program increasing risk

- The National Flood Insurance Program (NFIP) is designed to provide affordable insurance to residents who cannot find it in private markets.<sup>14</sup>
- It does not fix the problems of flooding, but merely pays for cleanup after a disaster occurs.<sup>15</sup>
- The NFIP exacerbates flood damages by incentivizing people to develop in dangerous flood prone areas.
- It is offered at artificially low rates that do not reflect the true risk of flooding.<sup>16</sup>
- It is based on outdated flood maps, some of which are currently being updated for the first time since the 1980s.<sup>17</sup>

- The NFIP repeatedly pays out to the exact same high-risk properties, with a quarter of all NFIP payments since 1978 accounting for such ‘repetitive losses’.<sup>18</sup>
- It has grandfathering provisions that unfairly subsidize property owners at the expense of others for risky infrastructure development in floodplains.<sup>19</sup>

## U.S. Levee Safety

- Levees are vital to protect life, property, ecosystems and economies.<sup>20</sup>
- The U.S. does not have a comprehensive approach to flood management and prevention, although Hurricane Sandy and Katrina have drawn more attention to the topic.<sup>21</sup>
- USACE only manages 14,700 miles of levees out of an estimated 100,000 miles of existing levees in the U.S.<sup>22</sup>
- This means that nearly 90% of the levees in the United States are not overseen by USACE. Many are not even tracked or monitored by a federal body<sup>23</sup>
- Recent developments are the completion of 75-miles of levees, floodwalls, gates and drainage pumps by the USACE in the New Orleans area at a cost of \$ 3 billion.<sup>24</sup>

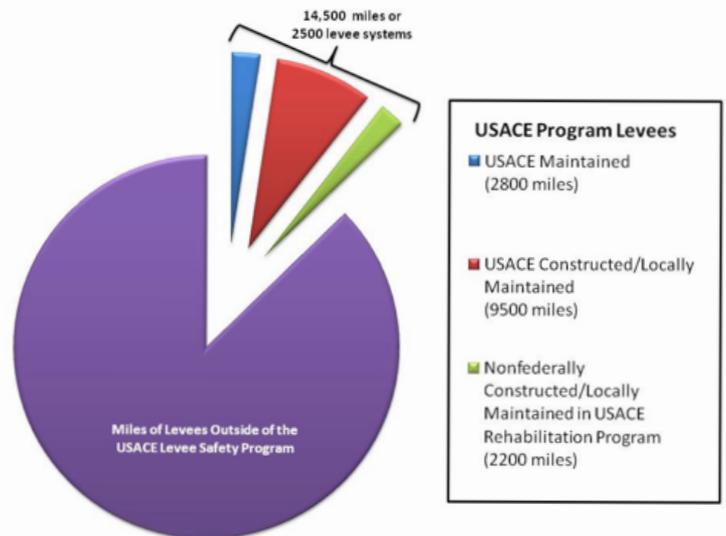
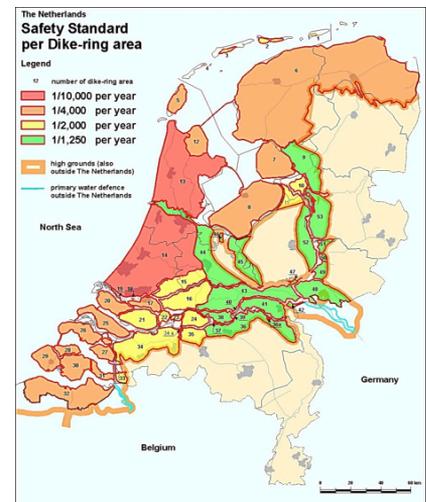


Figure: <http://www.usace.army.mil/Missions/Civil-Works/LeveeSafetyProgram/USACEProgramLevees.asp>

## Dutch Levee Safety Standards

- The Netherlands is a densely populated country with 16.8 million inhabitants,<sup>25</sup> (a little larger than the State of Maryland<sup>26</sup>) where two-thirds of the population lives below sea level.<sup>27</sup>
- In the U.S. the NFIP uses a flood protection level to guard against the 1-in-100 year flood.<sup>28</sup> This translates to a 1% chance of a flood in a given year, or a 26% chance of flooding during a typical 30-year mortgage.<sup>29</sup>
- In contrast, Dutch flooding safety measures use a more flexible approach that takes into account local conditions. Areas below sea level are divided into ‘dyke rings’,<sup>30</sup> which are unbroken rings of water defenses such as dykes/levees, dunes and high grounds.<sup>31</sup>

- Each dyke ring is required to withstand floods depending on their flood risk and potential damage. In areas that are less populated or located at higher altitude, they must meet standards for the 1/1,250 year flood.<sup>32</sup> In more densely populated areas or areas closer to the coast, the dyke rings must defend against the 1/10,000 year flood.<sup>33</sup>
- Each safety standard is based on the number of inhabitants and the economic value of assets that needs to be protected by the water defense infrastructure. The higher the quantified losses, the higher the required safety standard.<sup>34</sup>
- This is dramatically different from the U. S. approach, which only uses the 1/100 year calculation, regardless of the flood risk and protected property/life of individual coastal communities or states.



## Primary water defense system – the Delta project

The Dutch Delta project is a large scale primary line flood protection system, consisting of dams, locks, levees and storm surge barriers. It was constructed between 1958 and 1997.<sup>35</sup>

- It has over 10,250 miles of levees, 300 structures, and is one of the largest projects in the world.<sup>36</sup>
- Its aim is to better protect against flooding by shortening the exposed coastal line and hence the number of levees that need to be heightened.<sup>37</sup>
- The project achieved a reduction of the length of ocean exposed levees of approximately 450 miles.<sup>38</sup> Its total completion costs were \$6.6 billion.<sup>39</sup>
- The Dutch government uses an innovative cost-benefit analysis program, which allows it to calculate the economic optimal levee heights and required investment in the riskiest areas, taking into account quantified potential losses and future climate change. The new approach saved \$10 billion in levee reinforcement investments.<sup>40</sup>
- The U.S. has a significantly longer coastline than the Netherlands. However, using the Dutch approach, it can prioritize investment in key areas, such as the proposed \$ 10.3 billion ‘Morganza to the Gulf’ hurricane levee system near New Orleans<sup>41</sup> or Mayor Bloomberg’s suggested \$ 20 billion system to protect New York City’s 520 mile long coast.<sup>42</sup>



Figure: illustrates how the Delta Project (the blue lines) keep the ocean out on the left side and hence reduce the coastal line exposed on the right side (the dykes/storm surge barriers have huge open ‘lock’ doors that lose in case of storm surges/ adverse weather circumstances) [http://en.wikipedia.org/wiki/File:Deltawerken\\_na.png](http://en.wikipedia.org/wiki/File:Deltawerken_na.png)

## Secondary water defense system – dunes and beaches

### “The Sand Engine”

- Sand dunes are an important natural barrier to beach erosion and flooding.<sup>43</sup>
- The U.S. coastal line is regularly replenished by the USACE at high costs.
- USACE estimated the 10-year costs for the coastal line of New Jersey, North Carolina and Florida at almost \$ 5.5 billion.<sup>44</sup>
- As an alternative, the Netherlands government decided to deposit 21.5 cubic meters of sand in the form of a peninsula in front of its coast, also known as the “Sand Engine”.<sup>45</sup>
- Simulations show that wind, tides and streams will naturally redistribute the sand to the coastal line, creating 86 acres (240 football fields) of wider beaches and stronger dunes.<sup>46</sup>
- The project will make sand nourishments unnecessary for a period of 15-20 years<sup>47</sup>, strengthen the coastal water defense system, and is currently creating 316 acres (200 football fields) of additional wildlife and recreational space.<sup>48</sup>
- According to Delft University coastal engineering professor Marcel Stive ‘the Sand Engine helps to look 200 years into the future,’<sup>49</sup> because it mimics the effects to the coastal profile that happen under an increasing sea level.<sup>50</sup>
- The concept could be modified and applied to the U.S. east coast, where sand nourishments take place regularly.



## New Concepts – Living with Water

Perpetually strengthening levees and containing rivers can be costly and significantly increases the devastation of catastrophic flooding.<sup>51</sup> Therefore the Netherlands developed several concepts of “living with water”.

### “Room for the River”

- “Room for the River” is a \$3.1 billion<sup>52</sup> project that involves buying out landowners and moving back river levees at 30 locations, effectively creating controlled flood plains.<sup>53</sup> This allows flood prone areas to absorb excess water during severe storms.<sup>54</sup>
- Although there is a trade-off for those who give up land, the project improves safety of 4 million citizens<sup>55</sup> and creates opportunities like the development of additional parkland and economic benefits of new high-value water-front land.<sup>56</sup>

- By removing the perverse incentives in the NFIP that leads to more development in flood prone areas, the U.S. can improve the security of its citizens, protect military and economic interests, and create opportunities in areas like New Orleans or the Hampton Roads.



### “Underground storage of storm water runoff”

- The Dutch applied a holistic approach to the use of existing infrastructure and the creation of additional storage capacity for storm water runoff.
- For example, the city of Rotterdam constructed separate water basins underneath parking garages that can rapidly absorb 2.6 million gallons of water in case of severe storms, increasing the city’s storm drain capacity by half.<sup>57</sup>
- These solutions that make optimal use of scarce space could be applied to American cities like New York, St. Louis and New Orleans, without severely disrupting the existing infrastructure.



## Conclusion

The U.S. is not adequately prepared to deal with natural disasters, and climate change will make catastrophic disasters and flooding worse. The National Flood Insurance Program provides perverse incentives for people to live and work in high-risk flood areas.

The American system focuses on disaster relief instead of flood control and prevention.

The Netherlands is a global leader in flood management solutions and can offer lessons for the U.S. The Dutch approach can help America to cost effectively target risky areas through implementing primary hard and secondary natural defense systems. Dutch rational levee safety standard, innovative coastal line sand nourishments, “Room for the river” and “Underground storage of water runoff” concepts should be prioritized in areas in the U.S.

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