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THE IMPACT OF WEATHER CONDITIONS ON AMPHIBIOUS MILITARY OPERATIONS

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INTRODUCTION

Amphibious operations are one of the most difficult military operations to plan, organise and conduct efficiently. This difficulty is mainly derived from the great number of details that military strategists must consider when planning an amphibious operation. Moreover, many of these details cannot depend on human intervention and an amphibious operation can do anything apart from adapt to these limits. Weather conditions are one of these details, and they cover a fundamental role in amphibious operations. Sea state, wind, rain or even a sunny day, can heavily affect the conduct of an amphibious operation, both favourably and unfavourably, forcing military strategists to avoid, adapt, or prefer a certain weather condition instead of another one. Weather affects landing operations with amphibious vehicles, air operations, and naval operations in support of the landing troops.

This paper will analyse how weather conditions impact amphibious planning and the conduct of military operations. More precisely, this paper will scrutinize the different components of the broader concept of weather, assessing the impact that these components can have on amphibious warfare. To write this Info Flash, mainly sources coming from the US Marine Corps were taken into consideration, since they regularly publish analyses and studies. However, analysing the American doctrine regarding amphibious operations makes it possible to make similar considerations for the NATO doctrine, since the Alliance's doctrines are considerably influenced by the US despite not being public knowledge.

THE DIFFICULT RELATIONSHIP BETWEEN WEATHER AND AMPHIBIOUS OPERATIONS

To understand the importance of the weather during an amphibious operation, it is enough to take the example of the biggest amphibious operation ever conducted: D-Day. The date of D-Day was carefully selected and was decided according to weather forecasts. Eisenhower tasked a special team of experts, led by Group Captain James Stagg, to prepare weather forecasts and to test them during the months before the invasion. The initial date for D-Day was supposed to be the 4th of June 1944, however, Stagg and his team forecasted that weather conditions were not ideal for an amphibious operation, and the invasion was postponed until the weather turned favourable (Imperial War Museums, 2022). The delay meant that the invasion would have been postponed by two weeks due to very bad meteorological conditions for that period. The decision to delay the entire operation was an enormous risk since the surprise effect was fundamental in that operation, and the delay increased the possibility that Germans would have discovered the plans. However, Stagg anticipated a bad-weather break on the 6th of June, convincing Eisenhower to plan the invasion for that day. The forecast was right and, despite some difficulties linked to the strong wind, the Allies conducted the most successful military operation of World War II (Imperial War Museums, 2022). However, the weather is quite a general concept and should be divided into the elements that compose it to effectively analyse the impact it has on amphibious operations. It is possible to identify six main meteorological components that can have an impact on these types of operations: clouds, state of the sea, wind, fog, tide, and temperature.

Figure 1. "Into the Jaws of Death". D-Day disembarkation of Company A, 16th Infantry, 1st Infantry Division, Robert F. Sargent, June 6, 1944 [Source: https://upload.wikimedia.org/wikipedia/commons/thumb/a/a5/Into_the_Jaws_of_Death_23-0455M_edit.jpg/640px-Into_the_Jaws_of_Death_23-0455M_edit.jpg].

The **state of the sea** is the first, and probably the most important meteorological component from an amphibious point of view. To estimate the state of the sea, the Douglas Sea State Scale is generally used as the main reference spectrum, also by the World Meteorological Organization. This scale classifies the condition of the sea surface in 9 grades, by taking into consideration the wind and the swells (Jackson Parton Solicitors, 2022). Regarding naval military operations in general, the sea state is a key component since ships' effectiveness highly depends also on the conditions of the sea. However, a calm sea state is a fundamental prerequisite when it comes to amphibious operations. Landing crafts, and other amphibious vehicles' effectiveness, such as AAV-7s or ACVs, highly depends on sea conditions, both during navigation and during landing manoeuvres. For example, the ACV can operate only up to sea state 3 (BAE Systems, 2022), which means with waves from 0.5 m to 1.25 m high (Jackson Parton Solicitors, 2022).

Figure 2. An AAV-7 prepares to embark on the amphibious dock landing ship USS Carter Hall, US Navy Mass Communication Specialist Katrina Parker, August 28, 2008 [Source: https://upload.wikimedia.org/wikipedia/commons/thumb/c/ca/US_Navy_080828-N-3392P-183_An_amphibious_assault_vehicle_prepares_to_embark_the_amphibious_dock_landing_ship_USS_Carter_Hall_%28LSD_50%29.jpg/640px-US_Navy_080828-N-3392P-183_An_amphibious_assault_vehicle_prepares_to_embark_the_amphibious_dock_landing_ship_USS_Carter_Hall_%28LSD_50%29.jpg].

However, the sea state does not influence only the use of amphibious vehicles, but also aerial assets. The rolling or the pitch of an aircraft carrier or a helicopter carrier can impede the take-off of aerial assets from the flight deck. The state of the sea, therefore, explains how despite current technological improvements, actual amphibious vehicles and assets are still not able to overcome the obstacles posed by the sea. This impossibility to use vehicles for ship-to-shore operations impedes any amphibious assault, and it is for this reason that the state of the sea is extremely important in the planning phase of any amphibious operation. For these reasons, this paper assigns a "high" impact to the sea state in the risk assessment. Amphibious vehicles and aerial assets are fundamental for an amphibious operation since they are the link between the sea (ships) and land (coastal zones) (Zanotti, 2022), and the impossibility to use them determines the ability to execute an amphibious operation. This means that states of the sea have the power to delay, preclude, or even compromise an entire amphibious operation.

The second meteorological component that can affect amphibious operations is the presence of **clouds**. Here, clouds have a great impact only if they are very dense. Clouds have a double impact on an attacking amphibious force, especially regarding air operations. On the one hand, they can compromise the landing force supporting air operations, since aircraft and helicopters can incur many difficulties without visibility (Global Security, 2022). On the other hand, they can positively affect the attacking side. Indeed, clouds offer concealment for air reconnaissance, hiding reconnaissance drones and aircraft from the enemy's sight (Global Security, 2022). This element allows attacking amphibious forces to operate reconnaissance missions without compromising the element of surprise, which is one of the amphibious forces' main features. If clouds can hamper air support but can make reconnaissance more effective, it depends on the density of the clouds, and their impact highly rests on this condition. For this reason, it is possible to say that clouds have generally a "high" impact on amphibious operations because air support is fundamental as reconnaissance missions are. However, if the clouds are too dense to even hamper reconnaissance missions, they can have a mostly negative impact, but if they are too rarefied to not hamper air support, they can have no impact at all.

As far as the **fog** is concerned its impact must be considered. "Fog may impede, stop, or delay the ship-to-shore movement" (US Joint Chiefs of Staff, 2019) mainly because it can induce visibility problems. Due to the visibility issues it creates, fog can have both a positive and a negative impact on an amphibious operation. On the one hand, it can help landing forces maintain the element of surprise, like with clouds, because it can hide the approach to the beach. On the other hand, fog can impede landing craft movements, since it can hide obstacles, both natural and artificial defences. In addition, the reduction in visibility creates problems for close air support (CAS), air operations near the terrain, but also naval gunfire support. For these reasons, the assigned risk assessment is "medium", since it depends on the planners' ability to exploit the fog as a surprise effect catalyst and avoid difficulties linked to the lack of visibility.

Similar in terms of the effects it has on amphibious operations, the **wind** has a relevant but not extremely high impact. Sudden wind currents can cause several problems in carrying out a ship-to-shore operation. They can cause a variation in the state of the sea with all the above-mentioned consequences (Global Security, 2022). Moreover, extreme wind can cause problems for helicopters taking off from helicopter carriers. With particularly strong wind, pilots must conduct difficult manoeuvres, which can cause delays or even make it impossible to fly if pilots do not want to take risks. For these reasons, this paper estimates the impact of wind as "medium", since it can worsen the state of the sea or cause problems with helicopters' air operations. A clear example of the problems linked to the wind can be found in recent tragic events. During the Cold Response drill, the annual NATO exercise in Norway in March 2022, four US Marines died in a crash with an MV-22B Osprey in a

fjord. The cause of the crash was reportedly the extreme wind gusts, which, according to Oerjan Kristensen, the Red Cross team leader, were around 30-40 meters per second (The Guardian, 2022).

The last meteorological element that has an impact on amphibious warfare is the **temperature**. Extreme heat or cold can considerably slow down ship-to-shore operations, and impede prolonged stationing of soldiers in water, as is the case in cold temperatures. However, amphibious troops are trained and prepared to operate in high or low temperatures more than other components of the armed forces since the presence of the sea and the humidity highly affect the temperature in coastal zones (US Joint Chiefs of Staff, 2019). Moreover, extreme temperatures force troops to rely even more heavily on logistics, because they need special supplies. For example, in an extremely hot environment, troops need a lot of drinkable water to stay hydrated. On the contrary, in cold situations, troops need more food, but also special equipment, such as thermal jackets or heated shelters. Nonetheless, this paper assigns a "low" impact to the element of temperature. This decision was made since the temperature's effects can be mitigated by an efficient training program, special equipment, and good planning. If troops are trained to operate in hot or cold environments, they can easily overcome the difficulties posed by the temperature. In addition, efficient and quick logistic manoeuvres will provide all the necessary equipment to conduct amphibious operations even if the temperature is prohibitive. For this reason, the temperature can pose problems to amphibious operations, however, they can be overcome by an effective planning phase, without having a significant impact on the operation.

These components are not isolated cases, as a prohibitive sea state usually comes with strong wind and clouds, or fog usually appears with low temperatures and clouds. The problem is that different components bring different problems into an amphibious operation, and the sum of these problems can compromise the entire plan. However, it should be noted that all these components can be anticipated with modern technologies, and for this reason, it becomes fundamental for strategists to consider them during the planning phase, as happened in several historical cases, such as D-Day.

Table 1. Risk assessment table for meteorological events on amphibious operations. Source: Author.

Meteorological Component	Impact		
	Low	Medium	Low
State of the Sea			
Clouds			
Wind			
Fog			
Temperature			

CONCLUSIONS

Looking at the current situation in Ukraine, it is clear the absence of Russian amphibious operations is not entirely attributable to meteorological explanations. However, it is possible bad weather and sea conditions could have had an impact on the decision not to risk an amphibious attack on Mariupol or Odesa (Mills, Heck, 2022). As this Info Flash shows, weather affects the planning phase of any amphibious operation, and to be able to predict, and adapt to it is a fundamental capability that amphibious forces around the world need to be able to conduct an effective operation. State of the sea, clouds, wind, fog, and temperature are the components that, with different degrees of impact, most affect amphibious warfare. To conclude this analysis of weather conditions and their impact on amphibious military operations, it is useful to recall the thoughts of Brigadier General Oliver Smith of the US Marine Corps, who in his analysis of the planning phase of an amphibious operation, stated that one of the fundamental elements to be taken into consideration when selecting the time and date of a landing operation is the weather (Smith, 1945).

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