TEMPERATE REGIONS:
INFLUENCES ON MILITARY OPERATIONS, PART 1

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EDITOR'S NOTE: This article is Part 1 of a two-part series on the temperate regions of the world and their environmental effects on military operations. It discusses the environmental uniqueness of temperate regions, the terrain and its military aspects, observation and fields of fire, obstacles, cover and concealment, and avenues of approach. Part 2, scheduled for the September–October 1993 issue, will discuss the effects of the weather and terrain on soldiers, equipment and facilities, and combat and support operations.

This series concludes Colonel Clegg's INFANTRY articles on the various regions of the world, which include "Environmental Influences on Desert Operations" (May–June 1992); the two-part "Cold Regions: Environmental Influences on Military Operations," co-authored with Brigadier General Peter W. Clegg (July–August and September–October 1992); and the two-part "Tropical Regions: Influences on Military Operations" (March–April and May–June 1993).

This entire series of articles is intended to provide a complete reference that military instructors and leaders can use in preparing soldiers to train for or operate in any part of the world to which they may be deployed.

Although temperate regions make up only about five percent of the earth's land surface, they contain most of the world's population. With a dense settlement of 250 people per square mile in these regions, the probability of conflict is high (see map for 20th-century conflicts.) Since the environmental conditions in temperate regions are relatively mild, casualties directly attributable to environmental factors are not as striking as in other climatic areas. Nevertheless, the unique and variable conditions in these regions have resulted in death and, more often, have seriously affected military plans and operations.

Most of western and central Europe fall into a temperate region, and the U.S. Army has participated in both World Wars in that area. For the 50 years since World War II, most U.S. Army training has continued to focus on central Europe. Even if the Army's future involvement in this part of the world

is only in a peacekeeping role, understanding the environment, the terrain and its military aspects—observation and fields of fire, obstacles, cover and concealment, and avenues of approach—will be vital to success.

Climatic and Meteorological Conditions

The temperate regions are generally those of the middle latitudes between 20 and 40 degrees north and south. In Europe, however, the temperate region extends as far as 60 degrees north. The climate of this region is characterized by long, hot summers and short, mild winters; and it has four distinct seasons.

The scientific classification of the temperate climate includes three major subclimate types: mediterranean, humid subtropical, and marine west coast.

The mediterranean subclimate has hot dry summers with clear skies and moist winters. Summer conditions are brought on by sinking air from subtropical high-pressure cells; this air is stable, which reduces cloud formation and precipitation. These cells migrate toward the equator in winter, allowing westerly winds to influence conditions that in summer are farther north. The westerly winds bring frontal weather patterns, which result in stormier conditions with precipitation and milder temperatures. In the higher elevations of the mountains along the rim of the Mediterranean Sea, the precipitation can be in the form of snow. This climate is also found in southern California (around San Francisco), central Chile, and southern Africa and Australia; it is mostly restricted to the western parts of continents.

The humid subtropical subclimate is known for its severe summer humidity. Summers are long and hot, and precipitation is abundant throughout the year. Winters are short (three months or less) and mild with little snow and with temperatures above freezing (except at higher altitudes).

The dominant controlling factor is latitude, the same as in the mediterranean subclimate. This control reflects changing solar duration and intensity because of the earth's inclination and its revolution around the sun—hence, the four seasons. The humid subtropical subclimate is found mostly in the eastern portions of continents. The largest such areas are the southeastern portions of North America and of China.

The marine west coast subclimate is found closer to the poles (40 degrees to 60 degrees latitude) and therefore has cooler temperatures. As its name implies, it is found on continental west coasts. Nearly all of western Europe has this relatively mild climate, as does North America's Pacific Northwest. At this higher latitude, westerly winds prevail, bringing ample year-round precipitation from the oceans. Cloudiness and fog are the norm.

Ocean currents are a major control on this subclimate. The huge circular currents of ocean water bring warm, moist air to the land on continental west coasts. Ocean water warms as it moves west parallel to the equator. Land masses channel this water toward the pole and then east, bringing extraordinarily warm air to high latitude areas. The Gulf Stream (North Atlantic Current) and the Japanese Current are responsible for mild conditions as far north as southern Alaska and Scandinavia. Even the warm waters of the Gulf Stream move north above Norway into the Arctic Ocean and provide Russia its one ice-free port, Murmansk, above the Arctic Circle. It also gives western Europe its temperate climate. Western Europe is at about 50 degrees north latitude, the same as Canada, yet Canada's climate is cold.

Weather conditions in the temperate regions are characterized by significant and rapid change. Even within the four distinct seasons, the conditions vary considerably. The jet stream is a dominant control on this variability. It consists of high-speed winds (up to 300 knots) from the west at altitudes of about 30,000 feet. The oscillation of the jet stream, resulting from pressure differences to the north and south, allows colder air masses (bodies of air of similar temperature and humidity) to move south and warmer air masses to move north. These air masses converge and fight for control. Cold air from the poles meets warm air from the tropics at the "front," a battleground of conflicting air masses.

Conditions on either side of this line of contact are quite different from those along the front itself. Behind the cold front, temperatures are cool, pressure is high, skies are clear, and conditions are stable. Behind a warm front, temperatures are warmer, pressure lower, and skies partly cloudy and relatively stable, but storm conditions prevail at the front.

If a cold front encounters a warm air mass, the air is forced rapidly upward, resulting in heavy precipitation for a short time. If a warm front meets a cold air mass, the air rises more slowly, resulting in gentle rain lasting several days from a blanket of stratus clouds.

High-pressure areas to the south and north of the middle latitudes cause air to flow out of these high-pressure cells from west to east. This air flow moves fronts across oceans, where they pick up moisture and then onto continents where they dump the moisture. If the oscillation of the jet stream is great, air moves into the middle latitudes from the north and south, affecting local weather conditions. It is this variability in air flow that gives temperate regions their changing weather.

Alternating low-pressure and high-pressure systems, with their associated fronts, can have a major influence on military operations. Low-pressure means instability, involving wind and precipitation—two factors that restrict visibility and movement, as well as the soldiers' ability to fight.

Frontal storms threatened the Normandy landings in World War II. General Dwight Eisenhower recognized that the success of Operation OVERLORD depended on several weather conditions:

- Clear skies both day and night with a full moon to permit bombing and air cover for the amphibious assaults.
- Three miles of visibility from ship to shore to facilitate naval gunfire.
- Low tides to reveal obstacles on the beaches.
- Calm seas so the landing craft would not capsize and the soldiers would be less likely to get seasick.
- Light winds to clear away the fog.

The probability of finding such conditions in the English Channel is one in 50, and predicting them accurately is nearly impossible.

The desired time of attack was early June 1944. During the first five days of June, six low-pressure frontal systems passed over England and France. None of Eisenhower's criteria were met and he postponed the operation. But on 6 June it appeared that there would be a break in conditions between the advancing fronts. With more than 100,000 soldiers and hundreds of naval vessels and aircraft marshalled, Eisenhower took a chance that the period between the fronts would be long enough to allow the landing. He gave the green light. (The Germans, failing to forecast this short break, assumed the weather would preclude an assault.) After the initial landings, however, the fronts and their storms returned, making subsequent landings and the build-up of the beachhead slow and dangerous.

Despite fronts that constantly change weather and sometimes create extreme conditions, the temperate regions normally experience relatively mild temperatures. Although maximum daily highs often reach 100 degrees Fahrenheit, the summer average is between 75 and 85 degrees. The critical temperature for military operations is 72 degrees; above this temperature, soldiers and equipment begin to experience heat-related problems. Along coastal areas, temperatures are a few degrees cooler in summer because of the moderating effect of the oceans (water heats more slowly than land).

Winter temperatures average about 50 degrees Fahrenheit, which is where the danger of cold injuries begins to appear. This 50-degree average temperature has a range of nearly 40 degrees, which means it can get unseasonably warm but can also drop to near zero. Although the high and low temperatures are not extreme, adjusting to such wide ranges of temperature is difficult.

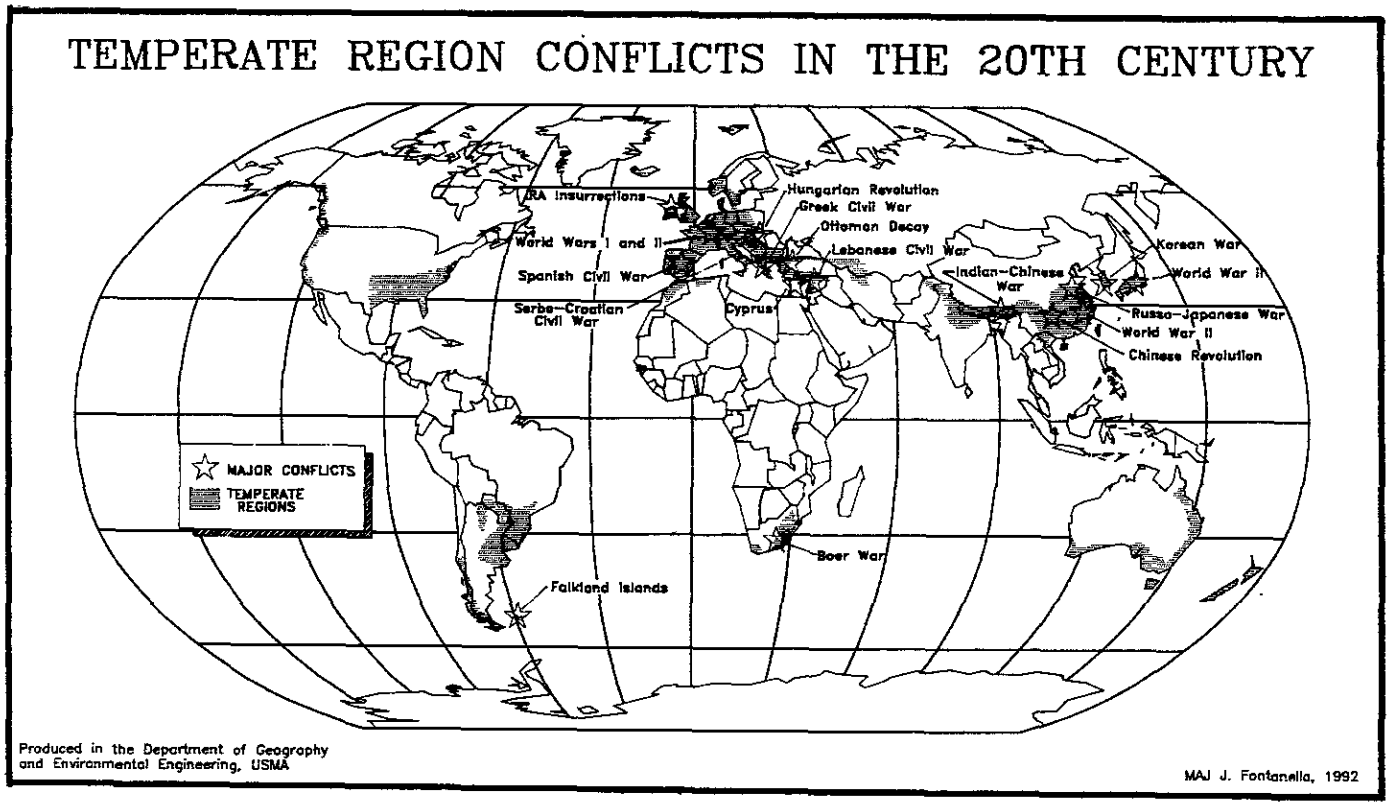
Humidity is pervasive in temperate climates, and precipitation distinguishes the three temperate subclimate types. Only in the mediterranean subclimate is rainfall sparse; it characteristically receives its rain in winter from the frontal flows. Both the humid subtropical and the marine west coast subclimates get evenly distributed rainfall year-round.

The mediterranean subclimate gets between 15 and 25 inches of rain a year (coastal areas may receive slightly more). The other subclimates get an average annual rainfall of up to 60 inches, with up to 100 inches in some coastal locations.

Precipitation in the marine west coast areas is mostly frontal. Two air masses collide, forcing air to rise and cool and moisture to condense and fall. This more gradual process results in gentle rain of long duration. In winter, frontal lifting may produce snow when the Canadian or Siberian high-pressure cells force cold air southward. Even the rim of the Mediterranean Sea occasionally gets snow, as in the winter of 1991–92 when it snowed in Lebanon, Israel, and Jordan. The snow rarely accumulates, however, and melts quickly.

The humid subtropical subclimate is best known for its stifling humidity. Although temperatures are not extreme, a relative humidity of 60 to 90 percent all summer drastically reduces the comfort level. Wet-bulb temperature is therefore high (above 80 degrees), and soldiers must reduce their level of activity. The heat in this subclimate produces convection cells in which the hot air at the surface rises and cools. With such high humidity, only a slight drop in temperature produces condensation, while a faster drop can cause brief but intense precipitation or late-afternoon thunder and lightning storms.

In the coastal locations of the marine west coast subclimate, high humidity often produces thick fog (on one day out of three in such places as the Pacific Northwest and western Europe). This fog occurs when warm air moves over a cold surface, such as the ocean or snow-covered land. The warm air ab-



sorbs moisture and cools suddenly, allowing for condensation. This kind of fog can be thick and can persist for days. Inland fog is also common, appearing in the early morning when it is coolest. The dew point is easily reached because of high humidity, and fog collects in valleys and depressions. This fog usually burns off quickly but may persist until mid-day.

Temperate regions have variable pressure and winds. Fronts lead high-pressure air into low-pressure cyclones. As the front moves from the west, pressure drops, indicating poor weather. The pressure gradient between the high pressure behind the front and the lower pressure at the front determines the wind direction and speed. If the pressure is extremely low, the gradient will be steep and the wind strong. The direction of the wind is from the high pressure into the low pressure in a counterclockwise direction (west to east, then north) around the center of the low-pressure cyclone (or in the Southern hemisphere, clockwise, west to east, then south). Although prevailing winds are from the west in the middle latitudes, wind direction depends, of course, on location in relation to the center of the low-pressure cell and on terrain influences.

Fronts are also responsible for major storms in temperate regions. Other storms include hurricanes and tornadoes, which are extremely low-pressure cyclones. These storms can generate dangerous winds—over 74 miles per hour for hurricanes and 500 miles per hour for tornadoes. Their course often brings them into temperate areas of continental east coasts (southeast United States and southeast China). Tornadoes occur in spring, when advancing warm air meets the cold northern air. Although most tornadoes occur in the semi-arid regions of the midwestern United States, they also occur in the humid subtropical regions of the southern and southeastern United States. Thunderstorms also cause havoc: Flash flooding can occur, and lightning kills more than 100 Americans each year.

Terrain Analysis

The topography in temperate regions is as variable as the weather. Landscapes include mountainous areas, rolling hills, and flat coastal plains. Unique landscapes are associated with the underlying rock. For example, *karst* topography, found in Kentucky, parts of Germany, and Yugoslavia (among other places), occurs on top of limestone. The limestone dissolves easily with water from rain, which leaves the terrain pitted with sinkholes and underground caverns.

Mountains dominate in the mediterranean subclimate. Mountain ranges include the Pyrenees and Iberian Mountains in Spain, the Apennines and Alps in Italy, the Denaric-Grecian Mountains in Yugoslavia and Greece, the Taurus Range in Turkey, the Lebanon Mountains, and the Atlas Mountains of North Africa.

The mountains in these ranges are mostly folded and faulted terrain, but volcanic mountains are also common. These mountains have steep slopes that preclude off-road vehicle movement, and switch-back roads have been built over the centuries. Some volcanic areas are still quite active—Mount Etna in Sicily was active as recently as 1992. Mountains are generally between 1,000 and 4,000 feet high; isolated peaks are much higher—Mount Etna (10,902 feet), Mount Corno in the Apennines (9,554 feet), Mount Mulhacen in the Spanish Sierra Nevadas (11,424 feet), Arin Ayachin in the Atlas Mountains of Morocco (12,261 feet), and Mount Olimbos in Greece (9,570 feet).

Mountains are also found in the marine west coast areas of Oregon and Washington and north into British Columbia and Alaska. The Cascade Range of this area is volcanic in origin, formed as a result of tectonic plate activity. Violent eruptions, such as those of Mount Saint Helens in 1980, occur occasionally along this coastal area. These mountains are quite steep, denying trafficability. The Cascade and Coastal Ranges also include steeply folded and faulted mountains.

In the humid subtropical areas, mountains are also dominant features. Southeast China is much more mountainous than the U.S. southeast. In both locations, the mountains are about 1,000 to 5,000 feet with peaks over 7,000 feet. Although the Appalachian chain does not have the area of the mountains of China, they are still formidable to units moving cross-country.

Hilly topography characterizes much of marine west coast Europe north of the Alps. These hills, from 500 to slightly over 1,000 feet in elevation, are far less steep than the mountains of the mediterranean region, although in selected areas they are effective obstacles to cross-country trafficability. The foothills of the Piedmont area of the Appalachians also fit this description. *Escarpments*, *cuestas*, *horsts* and *grabens* are unique topographic features that have linear ridges with steep cliffs.

The flat plains of the temperate regions are associated with coastal areas or the floodplains of major rivers. There is little flat land in mediterranean subclimate areas. Coastal flats rarely extend more than 10 miles inland. The floodplains in this subclimate area are not large except for the Po River Valley of northern Italy, which has a floodplain that is about 60 miles across. In the marine west coast areas of western France, Belgium, the Netherlands, and northern Germany are vast flat expanses extending more than 100 miles inland. The Rhine River in Germany has cut a wide floodplain tens of miles wide in some places and empties across the lowlands of Holland.

In the humid subtropical southeastern United States, a coastal plain along the Atlantic coast is 200 miles wide in some places. In South America, the Parana River basin is flat, covering the entire humid subtropical area of the continent. In India, the Ganges River has a flat floodplain more than 150 miles wide.

Surface cover also varies in temperate regions. It includes rock and soil, vegetation, drainage features, and man-made features. In the mediterranean areas, the soil is thin and very rocky. The thin soil has a crumbly texture and is susceptible to erosion. In the dry summer, the soil hardens into a compact surface; it lacks organic matter and has more of a sandy texture, but can soon turn into mud in the wet winter. In World War II, U.S. units bogged down in the quagmires of the Apennines in Italy.

The rock structure of the marine west coast areas also varies. In the Pacific Northwest, igneous lava rocks are more common than in Europe, where layers of sandstone, shale, and other sedimentary rocks predominate. The soils are derived

from the rock material and organic matter from coniferous trees and agricultural debris. The soil is deep (up to several feet in some places) with a high clay content which can become muddy when wet. In coastal areas, inundated soils with high organic content produce peat bogs.

In the humid subtropical areas, rocks of igneous and metamorphic origin dominate the high ground while softer sedimentary material covers the valleys and plains. The soils are either dark and thick (as in northern Argentina and Uruguay), or reddish, fairly deep, and acidic as in China and southeastern North America. Given rain, mud is a concern in these areas as well.

Vegetation is also highly varied. In the mediterranean subclimate regions, woodland and shrubs dominate with areas of open grass and scattered stubby trees. Tree spacing is fairly wide, and trunk diameters are generally small. Grains and vegetables are grown along the coasts and in the river valleys. Cacti are also common in many mediterranean areas. Pasture for sheep and goats is more common than pasture for cows.

In the marine west coast subclimate areas, forests and agriculture exist together. The Pacific Northwest is famous for its wide expanses of coniferous forests with a variety of evergreen species. The trees can be closely spaced, and some forests have extremely tall and large-diameter trees, such as the redwoods in California. Underbrush is reduced in the forests of closely spaced conifers, especially in Europe, where forested acreage is also reduced. The woods that do exist are intensely managed with regular trimming of branches and removal of underbrush. Softwoods make up most of the stands, but there are also selected hardwoods and deciduous species. The trees are grown especially close together—only a few feet apart—and are selectively harvested.

Trails through the larger stands of trees (100 square miles) become quagmires when wet. The interconnecting trails are wide enough for only one vehicle in the deep forest, and units need guides, trail markings, or prior reconnaissance to avoid getting lost.

The land that is not covered by woods is cultivated. Grains, vegetables, and pasture cover vast areas. These fields also become quagmires when wet because the soil has a clay texture, a high organic content, and considerable depth.

In Europe grapevines cover vast areas, often growing in rows on steep slopes, with wire strung from post to post to support them. The spaces between them are cleared but not wide enough for military vehicles, and movement on foot is extremely tiring.

In the humid subtropical areas, deciduous forests prevail. In the growing season, underbrush is thick with tall, thorny bushes. Intermixed with the broadleaf oaks, tulip trees, and maples, are needleleaf evergreen pines. Tree spacing can be quite close (within a couple of feet) with saplings even closer. In more mature forests, the trunks are up to several feet in diameter. In winter the leaves fall from the branches and shrubs, providing better visibility and access.

Agriculture is quite extensive in this subclimate type. Rice in China and wheat and other grains in South America are cash crops. In the southeastern United States, vegetables are grown in abundance, and orchards and specialty crops such as tobacco, cotton, soybeans, and peanuts are prevalent.

Abundant precipitation in the temperate regions leads to fine-textured drainage. The mountains and hills are cut by numerous streams that flow into larger rivers. In the mediterranean areas, the mountains have been heavily eroded by stream action. Channels are shallow (ten feet or less) and narrow (25 feet), and currents are swift only after winter rains. Streams compartmentalize the terrain, especially in Italy where rivers generally cut across the "boot" from the central spine of mountains. Flood plains are narrow, except for especially large rivers such as the Po, the Guadalquivir in Spain, the Sava in Yugoslavia, and the lower Rhone in France. Only the Po and the Rhone have significant deltas. Karst topography, previously mentioned, is a product of internal drainage, and drainage is extensive in the marine west coast and humid subtropical areas as well.

In western Europe, the Rhine River basin includes thousands of tributaries, some of which are major rivers (Moselle, Ruhr, Neckar, Main). The Seine and Loire in France and the Elbe in northern Germany are major basins as well, with thousands of smaller tributaries.

The humid subtropical areas also have major basins such as the Parana in Brazil, Paraguay, and Argentina, which is partially fed by melting snow from the Andes Mountains. Flat marshes are extensive in the river's floodplain, especially in Paraguay. Three of the world's largest rivers, the Ganges in northern India, the Yangtze in China, and the Mississippi in the United States, derive much of their flow from the humid subtropical rainfall. These rivers are major geographical features that divide and drain vast areas. Their flood plains are all more than 100 miles wide; they have major deltas, and meander over large areas. Marshes and swamps with standing water are also extensive in the coastal regions of these rivers.

With the dense population in the temperate region, the landscape is dotted with numerous villages and towns. In much of Germany, for example, villages are seldom more than two miles apart. Major cities with populations of well over a million are numerous (Shanghai, Canton, Rome, Milan, Madrid, Athens, Paris, Munich, Frankfurt, Hamburg, Berlin, London, Buenos Aires, Montevideo, Atlanta, Seattle, San Francisco). Thus numerous man-made features complicate the terrain. Unique features such as dikes in Holland and the hedgerows in the Normandy area of France also restrict movement and afford good opportunities for defense.

Military Aspects of Terrain

The weather and terrain of the temperate regions influence the conduct of combat operations. Although it is always necessary to evaluate the military aspects of terrain for the specific circumstances and locations at hand, it is of value here to generalize about them:

Observation and Fields of Fire. Topography, surface cover, and weather all influence observation and fields of fire. In the temperate region, there is usually enough high ground

to provide excellent observation and fields of fire into valleys and across flat coastal plains, but terrain masking does set limits. Drainage channels provide a significant amount of dead space that allows small units and even vehicles to advance undetected. Helicopters flying nap-of-the-earth can evade observation and be well hidden behind hills and in draws. The flatter terrain of the marine west coast areas often allows for unobstructed views as far as the eye can see, however.

The surface cover of the temperate regions presents problems with observation and fields of fire, since both vegetation and man-made features abound. In the sparse woodlands and shrubs of the mediterranean areas, vegetation is a lesser problem because of the wide spaces between the small stunted trees. Such man-made features as cities and villages restrict observation, maneuver, and fields of fire. Vegetation in both the marine west coast and the humid subtropical subclimates consists of needleleaf evergreen and deciduous forests, severely limiting observation except in the vast areas that are either under cultivation or fallow.

In winter, with a dusting of snow and with the deciduous trees leafless, observation is better. Man-made features again cause obstruction. The weather regularly limits observation, mostly in the marine west coast area where fog persists and rains are frequent. In the mediterranean areas, this problem is diminished and applies only to the short winter season. Fog and rain also reduce visibility in humid subtropical areas but to a lesser degree. The smog associated with cities limits observation significantly; this is a major consideration for the temperate regions because there are so many large cities. The degree of illumination at night is key to observation, as are seasonal changes in the amount of daylight. Winter offers only about nine hours of light, and summer about 15 hours.

Key Terrain. The high ground is invariably key terrain, because it dominates the local area. Mountain passes can be key terrain, as can river-crossing sites and such man-made features as airfields, bridges, rail hubs, or major bypass roads. From a strategic perspective, however, key terrain is more likely to be a cultural and political center, or a symbol of national resolve. The terrain around Verdun in World War I serves as an example of terrain that is key, both tactically and strategically.

The small city of Verdun is on the Meuse River in the northeast of France; to the north is Belgium and eastern Germany. The terrain around the city is high ground with steep slopes to the east into the Moselle River floodplain and a gentler decline to the west leading directly to Paris. The French had gone to great expense to fortify Verdun as part of the Maginot Line. The city was an old strongpoint that had stood as a symbol of French invincibility since the previous century; in February 1916 the Germans decided to challenge that invincibility.

The topography around Verdun consists of a series of five cuestas—ridges with steep faces on one side and gentle slopes on the other—running north to south, compartmenting the area. Rivers or streams flow north at the bottom of the steep cliffs, and tributaries cut deep gullies and ravines from the ridge line east and west into clay soil. The area around Verdun itself encompasses the easternmost cuesta. The last scarp (line of cliffs) descends to the Woevre Plain and the Meuse River. The top of the Douaumont Plateau, where there are small villages, is only about 1,000 feet in elevation but still about 600 feet higher than the lowlands. Vegetation at the time included forest on the steeper slopes and the plateau, and cleared agricultural fields elsewhere. The battle would center on Fort Douaumont, located on the northern tip of the cuesta.

The Germans were frustrated by a sudden change in the weather. Their plan included massive use of artillery, and a snow storm that raged across the area reduced visibility and precluded artillery forward observation. Deep snowdrifts in the valleys prevented the forward movement of German artillery and ammunition. The French were able to maneuver and met the attacking German infantry in fierce hand-to-hand combat. The weather changed again, just as quickly, clearing on 21 February. This allowed the Germans to marshal 2,000 artillery pieces and obliterate the French front lines. The French, however, had anticipated the massive barrage and had pulled most of their soldiers out of the frontline trenches, leaving only well-protected machinegun crews, most of whom survived. The Germans, always proficient tacticians, sent only patrols up the slopes of the plateau to meet their fate from the machinegun crews. They gained the initiative but little ground.

Spring rains brought mud that reduced action on the front to artillery duels. Trenches became stagnant pools, and vehicles bogged down. Relentless probes and frontal attacks gained little. The attacks shifted to the next ridge to the west where battles for Dead Man Hill, Hill 304, and Goose Crest became famous. The continuous artillery barrage devastated the land and destroyed the trees which had previously concealed French movements and supply trains, thereby allowing better observation for German planes. The battle for the ridge line, the high ground, continued all summer, again with little progress by either side.

Verdun was the epic battle of attrition. General Henri Philippe Petain planned to launch a counterattack to rid the region of the Germans. Now into October 1916, fog hid the terrain, and three weeks of rain left a thick mud that delayed the French. On 21 October the weather turned cold and clear, allowing for a two-day artillery preparation. On 24 October conditions again changed, warming and producing a thick fog that concealed the attacking French infantry. Their success was immediate, but it was not until December that they regained all the ground they had lost.

For ten months, the Germans had tried to take the Verdun cuesta and failed. The cost was more than one million casualties. The French had held, and their morale and esprit were lifted. The war then shifted west to the Somme River.

Obstacles. Terrain reinforcement always improves combat operations, but natural obstacles are abundant in temperate regions. Mountainous areas of the mediterranean and humid subtropical subclimate areas, and numerous streams and rivers over the entire temperate region, present formidable obstacles. During "The Long March" of the Chinese communists, Mao Tse-Tung and Chou En-Lai and their followers crossed

This 10th Mountain Division soldier takes advantage of the excellent fields of fire and observation near Vadetta, Italy, in March 1945.

18 mountain ranges and 24 rivers. Their initial strength of 100,000 was reduced to less than 20,000 after 368 days and 6,000 miles on foot.

Such terrain as compartmented cuesta and karst topography hampers troop movement. Coastal swamps, tidal basins, and towns, villages, and cities all present significant obstacles to military operations. Each of these types of obstacles cost the lives of numerous U.S. soldiers in World War II as they moved from North Africa to Sicily and to the Italian Alps. The Germans, under the able command of Field Marshal Albert Kesselring, used the mountainous terrain, the rivers, and the villages to great advantage in a well-executed delaying operation.

In Sicily, General George S. Patton, Jr., fought not only the Germans but also the terrain. The mountains of Sicily are extremely steep, and the roads permitted only one vehicle at a time to pass. Tunnels and bridges were numerous along the route to Messina, and each was well-defended by the Germans. Before yielding, they blew each tunnel or bridge, enabling a few skilled soldiers to hold up the entire 7th U.S. Army. In attempting to outflank German strongholds, U.S. soldiers had to climb the hills in 90-degree temperatures with little water.

As Patton approached Troina, such natural defensive positions and obstacles were everywhere. The town was on a high cliff that dominated all approaches. Ridges and peaks surrounding the town blocked access. Deep ravines that could have provided concealed routes had been mined by the Germans. The U.S. plan had called for a regiment to take the town, but it took a division plus a regiment to do the job.

The Americans also displayed skill in using terrain as an obstacle. At Salerno, Darby's Rangers, outnumbered eight to one, held Chiunzi Pass. From strongpoint positions in stone farmhouses they used this key high ground to adjust mortar, artillery, and naval gun fire.

Later in the war, as the Americans moved north toward Naples, the Germans used the rugged terrain of the Sorrento Peninsula to full advantage. Over 25 miles of twisting roads lay 25 blown bridges. As the Americans penetrated deeper into the mountains of the Apennines with snow-topped peaks of 2,500 to 6,000 feet, horses and mules were enlisted to provide transport. The terrain was such an obstacle that elements of the 3d Infantry Division attacking Monte la Defensa took as much as six hours to get casualties down the mountain. The costly battles of Monte Cassino highlighted the obstacle value of mountains. British Prime Minister Winston Churchill questioned General Harold R.L.G. Alexander about wearing out five or six divisions "in those jaws." Later in the campaign, U.S. forces lost 2,731 soldiers taking Noticelli and Monte Altuzzo in the drive on Bologna.

Two river-crossing operations in the Italian Campaign are excellent examples of this type of obstacle. In early October 1943, the 5th U.S. Army had to cross the Volturno River. VI Corps faced steep hills with narrow, winding roads and many bridges and culverts held by the Germans on the north side of the river. The Corps had to cross flat, open terrain flooded by the early winter rains. In the British X Corps area, the river was up to 300 feet wide and 11 feet deep.

The U.S. 45th Division moved northwest into the valley of the Calore River (a tributary of the Volturno); the 3d and 34th Divisions to the west attacked at the junction of the two rivers. The Germans, occupying the high ground and with clear observation, pounded the attacking divisions with mortar, artillery, and small arms fire during the crossing and inflicted heavy casualties.

At the Rapido River the Germans again held the high ground on the northern side. They had cleared all vegetation to improve observation and fields of fire, denying concealment to the attackers in the one-mile floodplain. Having control of upstream dams, they also flooded the flat land. To further complicate any crossing, they sowed mines in the marsh. The river itself was 25 to 50 feet wide; its banks were about four feet high with water depth up to ten feet. The flow was swift and the water was icy cold for the crossing. To reach the selected crossing site, the soldiers had to carry rafts two miles at night. Several disastrous attempts to cross resulted in more than 1,000 casualties in the 36th Division.

Throughout the Italian Campaign, the Germans used natural terrain obstacles to great advantage. At each opportunity,

they reinforced the terrain with wire, mines, and trenches. Other man-made obstacles can be emplaced or created by blowing structures or rock cliffs. Rubble in urban areas can close streets, and a valley can be blocked when demolitions collapse its walls.

The defensive systems on the western front in World War I and at Normandy in World War II serve as excellent examples of man-made obstacles that reinforce the terrain. The Meuse-Argonne Campaign of World War I was the final grand assault, launched on 26 September 1918. Twelve Allied armies of six million men were to attack German defenses, which consisted of a system of six trench lines 12 miles deep. General John J. Pershing commanded the U.S. operations in the tangled Argonne Forest sector, which bristled with barbed wire, minefields, and mutually supporting machinegun strongpoints. The French and the British had chosen a date before the autumn rains, realizing full well that the battlefield would be engulfed in mud, a natural obstacle. Artillery craters provided some cover and concealment but also retarded movement. Artillery fires had long since removed the trees, and soldiers advanced across open terrain into the German wire and minefields. The trenches provided temporary cover and concealment but also restricted movement. In the 47-day campaign, Pershing lost 26,227 Americans killed and 95,788 wounded.

The beaches of Normandy where 6,000 soldiers died were also layered with obstacles. Posts with mines at their tips were placed in the water so they would be concealed at high tide. Approaching landing craft would strike stakes and detonate the mines. Rail wedges laced with mines forced the landing craft helplessly up and out of the water, and steel gates blocked access to the beach. On the beach were layers of wire, concrete dragons' teeth, and mines. The beaches of Normandy were narrow with little depth, and the high ground and cliffs overlooked the beaches. Here, German tank ditches and spikes, as well as machinegun strongpoints, dominated the beach approaches.

Terrain reinforcement measures need not be sophisticated. In wooded areas where trails are narrow, an abatis or just a few cut trees across the trail will delay movement. All such obstacles should be covered by fire to increase their effectiveness.

Immediately after overcoming the obstacles of the Normandy beachhead, the U.S. First Army was confronted with the thick hedgerows that had been cultivated over the centuries to separate individual fields. These sturdy dirt embankments are normally one to four feet thick and between three and 15 feet high. Dense vegetation consisting of trees, vines, and brush encompass the entire thickness of the mounds and double their height. There is no pattern to these fields, which are only 200 by 400 yards and irregularly shaped.

This hedgerow country is obviously extremely compartmented, and the defender has excellent cover and concealment. The Germans were well aware of this favorable terrain obstacle and used the hedgerows to great advantage, delaying the U.S. advance for weeks. At opposite corners of each field, the Germans placed machineguns that pinned down the U.S. infantry. Mortars then caused 75 percent of the U.S. casualties.

Snipers were also important to the German defense, as were booby traps and mines. Using infantry alone to attack through the brush into the kill zone of the open field was foolhardy; integrated combat teams of tanks, engineers, and infantry were able to make progress with fewer casualties. Demolitions were emplaced to blow openings in the hedgerows to allow the tanks to advance. Although this seems simple enough, over a distance of one-and-one-half miles a company faced 34 separate hedgerows. Blowing openings in all of them would have required 17 tons of explosives per company, an overwhelming logistical problem. Instead, the tanks were modified with cutters on the front that would allow them to break through the thick vegetation. Attacks were still costly. On 5 July 1944 the 83d Division suffered 2,100 casualties while advancing only 1,600 yards.

Combined arms tactics were refined to overcome both the hedgerows and the Germans. Nonetheless, First Army suffered 100,000 casualties while inflicting a similar number on the Germans. The 29th Infantry Division suffered nearly 10,000 casualties, and rifle companies throughout the Army were reduced to half strength. The greatest shortcoming in the campaign was ignorance of the hedgerow country; combat leaders had no understanding of the nature of this obstacle.

Cover and Concealment

Although cover and concealment are site specific, some generalizations about the temperate regions provide an estimate of the availability of cover and concealment. In urban areas and smaller settlements, the structures offer cover. Basements and sewers provide good cover from artillery and air attack, but collapsing buildings can trap and kill soldiers.

During World War II much fighting occurred in the towns and cities throughout Europe. Many were leveled by artillery and bombing. The fighting was especially difficult because concealment was so good in the urban terrain.

Vegetation provides concealment as well as cover from small arms fire. Thick trees stop bullets and absorb fragments, and they may be cut and used to build fortifications when in the defense.

In the mountains, rocks and deeply cut gullies provide cover, and in karst regions, caves provide cover from both indirect and direct fire. In the mediterranean areas, stone farmhouses and walls protect soldiers from direct fire.

Weather and terrain can provide concealment as well. Fog, rain, snow, and low clouds conceal movement and positions from both ground and aerial observation, although thermal infrared sensors and radar may reveal targets, if the weather is not so bad as to degrade observation. The evacuation of the British Army of 338,000 men from Dunkirk in late May 1940 serves as an example of how the concealing effects of weather allow one side an advantage and also how darkness and smoke can be used to conceal operations.

On 26 May the British were under heavy pressure from Luftwaffe bombing, but the quickly changing conditions brought deteriorating weather with heavy rains. The Germans delayed their final panzer attack, but conditions were also bad for the

evacuation. A low-pressure Atlantic front system brought on stormy conditions and reduced the ceiling to 300 feet. A blocking Azores high-pressure system kept an oncoming storm to the north on 28 May, and although the surf was still high, 17,804 soldiers escaped. On 29 May concealing conditions precluded Luftwaffe operations until afternoon when the weather cleared. The German air force then attacked, inflicting great damage and many casualties. On 30 May mist and smoke prevented air operations and concealed the evacuation of another 53,000 soldiers, but on 31 May the clear high pressure system from the Azores prevailed, allowing three devastating air attacks on the ships. Because concealment from the weather was lost, the British used darkness instead until 4 June when the last boat left the continent.

The World War I counteroffensive by the French at Verdun used fog to advantage, and in World War II the Germans prepared for the Battle of the Bulge under the concealment of fog, mist, and low clouds. These examples demonstrate the highly variable frontal weather conditions that are typical of temperate regions and the prevalence of concealing weather in the marine west coast subclimate areas of Europe.

Surface cover and topography also provide concealment. The forests of the marine west coast and humid subtropical climates provide excellent ground concealment and overhead concealment, but the forests of Europe, with so little underbrush, may not provide the same degree of ground concealment. In the humid subtropical areas, dense shrubs and underbrush provide excellent ground concealment. The seasonal nature of deciduous vegetation markedly changes the concealment effect. When the vegetation is in full leaf, concealment is excellent, but in the winter dry seasons, the leaves have fallen, reducing both ground and overhead concealment, and making ground movement noisy.

Standard issue camouflage and battle dress uniforms are very effective in temperate regions. The sparse vegetation of the mediterranean subclimate provides limited ground or overhead concealment, but man-made features in both rural and urban settings provide excellent hide positions from advancing enemy soldiers and from aircraft. The densely settled areas of the temperate regions make this a major consideration.

The variable topography of the temperate regions provides ample terrain masking. Aircraft that are flying nap-of-the-earth are concealed from observation. The folded mountainous areas and the parallel ridge lines of cuestas conceal men and equipment in adjoining valleys. The steep mountain terrain and large rocks of the mediterranean subclimate provide excellent cover, as the Germans expertly demonstrated in Italy during World War II.

Avenues of Approach

Terrain masking also dictates avenues of approach. Folded mountains in the humid subtropical areas may provide the best example. In the southeast and eastern parts of the United States, natural avenues exist where the Appalachian Mountains form distinct parallel ridges extending for miles, generally from northeast to southwest. This is compartmented terrain. Movement in the valleys, parallel to ridge lines, is rapid while moving across compartments, up and down ridges, is slow and exhausting. These folds create a relatively narrow valley (such as the Shenandoah) usually with a river and high, steep ridges (Blue Ridge). General Robert E. Lee's Army of Northern Virginia repeatedly used this protected avenue during the Civil War to move north into the border states to threaten Washington and bring the war to the north. This same corridor allowed Lee to escape each time.

Estuaries and their peninsulas are also avenues of approach. The U.S. east coast has several major rivers that drain into the Atlantic, forming estuaries or bays that protrude inland for more than 100 miles in some cases. During the Civil War, the Union forces under General George McClellan used the estuary of the James River to advance 70 miles to Richmond, the Confederate capital in 1861. If he had been more aggressive, the Peninsular Campaign could have ended the war early.

General Thomas J. Jackson, using the valley and ridge topography of the Shenandoah, threatened Washington while Lee held the Union forces at bay just outside of Richmond. McClellan could not get the additional forces he thought he needed to finish the campaign because of Jackson's threat to Washington. Lee then ordered Jackson south, down the Shenandoah, to reinforce Richmond. As a result, the Union forces were pushed back, finally gave up, and withdrew north.

Rivers provide avenues of approach in the temperate regions. The Rhine River floodplain is extremely wide at its terminus in Holland and northern Belgium. From south of Liege, Belgium, to the French border is hilly terrain. The Germans' von Schlieffen Plan in World Wars I and II was to attack along this high-speed avenue of approach to penetrate deep into these two countries and then turn south to Paris. The avenue follows the terrain and is relatively flat along the entire route. The only concerns are the many rivers, which flow generally parallel but still require numerous crossings. The Germans bypassed the difficult higher terrain (which was defended) and were initially successful.

In the rivers and mountains of Italy, compartmented terrain limited the northward advance of the Allies in World War II, making an advance slow and costly. It is important to pay attention to flank security when moving through natural avenues of approach (usually the low land) and to control the high ground, the parallel ridges, when proceeding along the valley or river.

Fortunately, temperate regions do not have the extremes of cold, heat, wetness, and disease that so severely affect soldiers, their weapons and equipment, and support operations. The major problems here are caused by the rapid changes that can occur in weather conditions. The effects of these changes will be covered in the second part of this article.

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