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MOUNTAIN OPERATIONS

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Mountain Operations

Contents

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Preface

FM 3-97.6 describes the tactics, techniques, and procedures that the United States (US) Army uses to fight in mountainous regions. It is directly linked to doctrinal principles found in FM 3-0 and FM 3-100.40 and should be used in conjunction with them. It provides key information and considerations for commanders and staffs regarding how mountains affect personnel, equipment, and operations. It also assists them in planning, preparing, and executing operations, battles, and engagements in a mountainous environment.

Army units do not routinely train for operations in a mountainous environment. Therefore, commanders and trainers at all levels should use this manual in conjunction with TC 90-6-1, Army Training and Evaluation Program (ARTEP) mission training plans, and the training principles in FM 7-0 and FM 7-10 when preparing to conduct operations in mountainous terrain.

The proponent of this publication is Headquarters TRADOC. Send comments and recommendations on DA Form 2028 directly to Commander, US Army Combined Arms Center and Fort Leavenworth, ATTN: ATZL-SWW, Fort Leavenworth, Kansas 66027-6900.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

Introduction

The US Army has a global area of responsibility and deploys to accomplish missions in both violent and nonviolent environments. The contemporary strategic environment and the scope of US commitment dictate that the US Army be prepared for a wide range of contingencies anywhere in the world, from the deserts of southwest Asia and the jungles of South America and southeast Asia to the Korean Peninsula and central and northern Europe. The multiplicity of possible missions makes the likelihood of US involvement in mountain operations extremely high. With approximately 38 percent of the world's landmass classified as mountains, the Army must be prepared to deter conflict, resist coercion, and defeat aggression in mountains as in other areas.

Throughout the course of history, armies have been significantly affected by the requirement to fight in mountains. During the 1982 Falkland Islands (Malvinas) War, the first British soldier to set foot on enemy-held territory on the island of South Georgia did so on a glacier. A 3,000-meter (10,000-foot) peak crowns the island, and great glaciers descend from the mountain spine. In southwest Asia, the borders of Iraq, Iran, and Turkey come together in mountainous terrain with elevations of up to 3,000 meters (10,000 feet).

Mountainous terrain influenced the outcome of many battles during the Iran-Iraq war of the 1980s. In the mountains of Kurdistan, small Kurdish formations took advantage of the terrain in an attempt to survive the Iraqi Army's attempt to eliminate them. In the wake of the successful United Nations (UN) coalition effort against Iraq, US forces provided humanitarian assistance to Kurdish people suffering from the effects of the harsh mountain climate.

Major mountain ranges, which are found in desert regions, jungles, and cold climate zones, present many challenges to military operations. Mountain operations may require special equipment, special training, and acclimatization. Historically, the focus of mountain operations has been to control the heights or passes. Changes in weaponry, equipment, and technology have not significantly shifted this focus. Commanders should understand a broad range of different requirements imposed by mountain terrain, including two key characteristics addressed in this manual: (1) the significant impact of severe environmental conditions on the capabilities of units and their equipment, and (2) the extreme difficulty of ground mobility in mountainous terrain.

Chapter 1

Intelligence

Before they can understand how to fight in mountainous environment, commanders must analyze the area of operations (AO), understand its distinct characteristics, and understand how these characteristics affect personnel and equipment. This chapter provides detailed information on terrain and weather necessary to conduct a thorough intelligence preparation of the battlefield (IPB), however, the IPB *process* remains unaffected by mountains (see FM 2-01.3 for detailed information on how to conduct IPB).

SECTION I – THE PHYSICAL ENVIRONMENT

1-1. The requirement to conduct military operations in mountainous regions presents commanders with challenges distinct from those encountered in less rugged environments and demands increased perseverance, strength, will, and courage. Terrain characterized by steep slopes, great variations in local relief, natural obstacles, and lack of

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accessible routes restricts mobility, drastically increases movement times, limits the effectiveness of some weapons, and complicates supply operations. The weather, variable with the season and time of day, combined with the terrain, can greatly affect mobility and tactical operations. Even under nonviolent conditions, operations in a mountainous environment may pose significant risks and dangers.

TERRAIN

1-2. Mountains may rise abruptly from the plains to form a giant barrier or ascend gradually as a series of parallel ridges extending unbroken for great distances. They may consist of varying combinations of isolated peaks, rounded crests, eroded ridges, high plains cut by valleys, gorges, and deep ravines. Some mountains, such as those found in desert regions, are dry and barren, with temperatures ranging from extreme heat in the summer to extreme cold in the winter. In tropical regions, lush jungles with heavy seasonal rains and little temperature variation frequently cover mountains. High, rocky crags with glaciated peaks and year-round snow cover exist in mountain ranges at most latitudes along the western portion of the Americas and in Asia. No matter what form mountains take, their common denominator is rugged terrain.

MOUNTAINOUS REGIONS

1-3. The principal mountain ranges of the world lie along the broad belts shown in Figure 1-1. Called *cordillera*, after the Spanish word for rope, they encircle the Pacific basin and then lead westward across Eurasia into North Africa. Secondary, though less rugged, chains of mountains lie along the Atlantic margins of America and Europe.

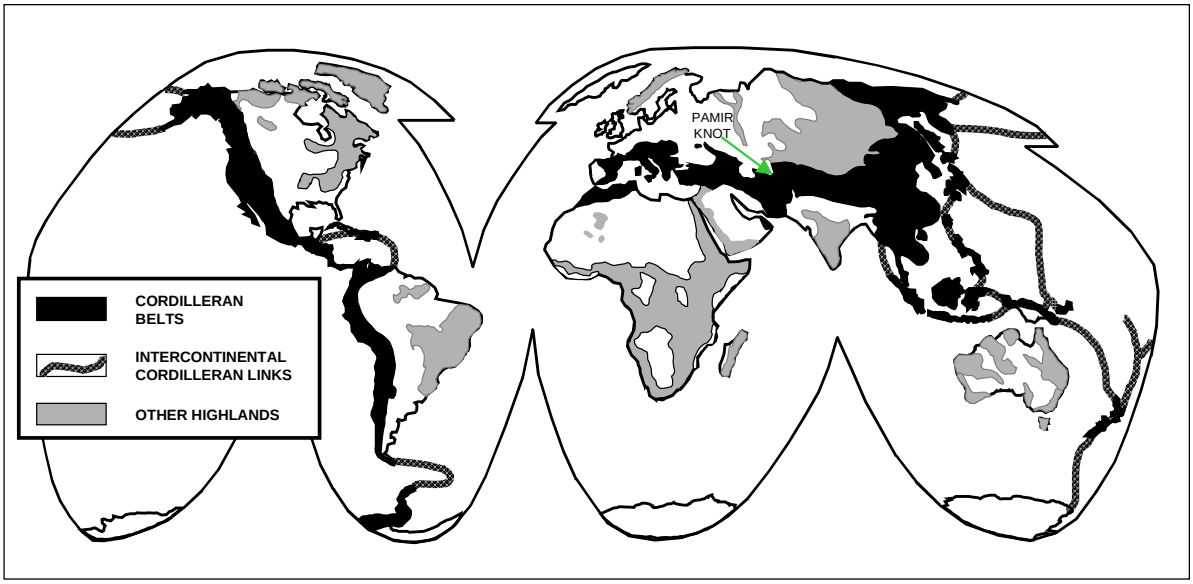

Figure 1-1. Mountain Regions of the World

1-4. A broad mountainous region approximately 1,600 kilometers wide dominates northwestern North America. It occupies much of Alaska, more than a quarter of Canada and the US, and all but a small portion of Mexico and Central America. The Rocky Mountain Range includes extensive high plains and basins. Numerous peaks in this belt rise above 3,000 meters (10,000 feet). Its climate varies from arctic cold to tropical heat, with the full range of seasonal and local extremes.

1-5. Farther south, the Andes stretch as a continuous narrow band along the western region of South America. Narrower than its counterpart in the north, this range is less than 800 kilometers wide. However, it continuously exceeds an elevation of 3,000 meters (10,000 feet) for a distance of 3,200 kilometers.

1-6. In its western extreme, the Eurasian mountain belt includes the Pyrenees, Alps, Balkans, and Carpathian ranges of Europe. These loosely linked systems are separated by broad low basins and are cut by numerous valleys. The Atlas Mountains of North Africa are also a part of this belt. Moving eastward into Asia, this system becomes more complex as it reaches the extreme heights of the Hindu Kush and the Himalayas. Just beyond the *Pamir Knot* on the Russian-Afghan frontier, it begins to fan out across all parts of eastern Asia. Branches of this belt continue south along the rugged island chains to New Zealand and northeast through the Bering Sea to Alaska.

MOUNTAIN CHARACTERISTICS

1-7. Mountain slopes generally vary between 15 and 45 degrees. Cliffs and other rocky precipices may be near vertical, or even overhanging. Aside from obvious rock formations and other local vegetation characteristics, actual slope surfaces are usually found as some type of relatively firm earth or grass. Grassy slopes may include grassy clumps known as *tussocks,* short alpine grasses, or *tundra* (the latter more common at higher elevations and latitudes). Many slopes will be scattered with rocky debris deposited from the higher peaks and ridges. Extensive rock or boulder fields are known as *talus*. Slopes covered with smaller rocks, usually fist-sized or smaller, are called *scree* fields. Slopes covered in talus often prove to be a relatively easy ascent route. On the other hand, climbing a scree slope can be extremely difficult, as the small rocks tend to loosen easily and give way. However, this characteristic often makes scree fields excellent descent routes. Before attempting to descend scree slopes, commanders should carefully analyze the potential for creating dangerous rockfall and take necessary avoidance measures.

1-8. In winter, and at higher elevations throughout the year, snow may blanket slopes, creating an environment with its own distinct affects. Some snow conditions can aid travel by covering rough terrain with a consistent surface. Deep snow, however, greatly impedes movement and requires soldiers well-trained in using snowshoes, skis, and over-snow vehicles. Steep snow covered terrain presents the risk of snow avalanches as well. Snow can pose a serious threat to soldiers not properly trained and equipped for movement under such conditions. Avalanches have taken the lives of more soldiers engaged in mountain warfare than all other terrain hazards combined.

1-9. Commanders operating in arctic and subarctic mountain regions, as well as the upper elevations of the world's high mountains, may be confronted

with vast areas of glaciation. Valleys in these areas are frequently buried under massive glaciers and present additional hazards, such as hidden crevices and ice and snow avalanches. The mountain slopes of these peaks are often glaciated and their surfaces are generally composed of varying combinations of rock, snow, and ice. Although glaciers have their own peculiar hazards requiring special training and equipment, movement over valley glaciers is often the safest route through these areas (TC 90-6-1 contains more information on avalanches and glaciers, and their effects on operations).

MOUNTAIN CLASSIFICATIONS

1-10. There is no simple system available to classify mountain environments. Soil composition, surface configuration, elevation, latitude, and climatic patterns determine the specific characteristics of each major mountain range. When alerted to the potential requirement to conduct mountain operations, commanders must carefully analyze each of these characteristics for the specific mountain region in which their forces will operate. However, mountains are generally classified or described according to their local relief; for military purposes, they may be classified according to operational terrain levels and dismounted mobility and skill requirements.

Local Relief

1-11. Mountains are commonly classified as low or high, depending on their local relief and, to some extent, elevation. Low mountains have a local relief of 300 to 900 meters (1,000 to 3,000 feet) with summits usually below the timberline. High mountains have a local relief usually exceeding 900 meters (3,000 feet) and are characterized by barren alpine zones above the timberline. Glaciers and perennial snow cover are common in high mountains and usually present commanders with more obstacles and hazards to movement than do low mountains.

Operational Terrain Levels

1-12. Mountain operations are generally carried out at three different operational terrain levels (see Figure 1-2). Level I terrain is located at the bottom of valleys and along the main lines of communications. At this level, heavy forces can operate, but maneuver space is often restricted. Light and heavy forces are normally combined, since vital lines of communication usually follow the valley highways, roads, and trails.

Level	Description
I	The bottoms of valleys and main lines of communications
II	The ridges, slopes, and passes that overlook valleys
III	The dominant terrain of the summit region

Figure 1-2. Operational Terrain Levels

1-13. Level II terrain lies between valleys and shoulders of mountains. Generally, narrow roads and trails, which serve as secondary lines of communication, cross this ridge system. Ground mobility is difficult and light forces will expend great effort on these ridges, since they can easily influence operations at Level I. Similarly, enemy positions at the next level can threaten operations on these ridges.

1-14. Level III includes the dominant terrain of summit regions. Although summit regions may contain relatively gentle terrain, mobility in Level III is usually the most difficult to achieve and maintain. Level III terrain, however, can provide opportunities for well-trained units to attack the enemy from the flanks and rear. At this terrain level, acclimatized soldiers with advanced mountaineering training can infiltrate to attack lines of communication, logistics bases, air defense sites, and command infrastructures.

Dismounted Mobility Classification

1-15. When conducting mountain operations, commanders must clearly understand the effect the operational terrain level has on dismounted movement. Therefore, in addition to the general mobility classification contained in FM 2-01.3 (unrestricted, restricted, severely restricted), mountainous terrain may be categorized into five classes based on the type of individual movement skill required (see Figure 1-3). Operations conducted in class 1 and 2 terrain require little to no mountaineering skills. Operations in class 3, 4, and 5 terrain require a higher level of mountaineering skills for safe and efficient movement. Commanders should plan and prepare for mountain operations based, in large part, on this type of terrain analysis.

Class	Terrain	Mobility Requirements	Skill Level Required*
1	Gentler slopes/ trails	Walking techniques	Unskilled (with some assistance) and Basic Mountaineers
2	Steeper/rugged terrain	Some use of hands	
3	Easy climbing	Fixed ropes where exposed	Basic Mountaineers (with assistance from assault climbers)
4	Steep/exposed climbing	Fixed ropes required	
5	Near vertical	Technical climbing required	Assault Climbers
* See Chapter 2 for a discussion of mountaineering skill levels			

Figure 1-3. Dismounted Mobility Classification

WEATHER

1-16. In general, mountain climates tend to be cooler, wetter versions of the climates of the surrounding lowlands. Most mountainous regions exhibit at least two different climatic zones – a zone at low elevations and another at elevations nearer the summit regions. In some areas, an almost endless variety of local climates may exist within a given mountainous region. Conditions change markedly with elevation, latitude, and exposure to atmospheric winds and air masses. In addition, the climatic patterns of two ranges located at the same latitude may differ radically.

1-17. Like most other landforms, oceans influence mountain climates. Mountain ranges in close proximity to oceans and other large bodies of water usually exhibit a *maritime climate.* Maritime climates generally produce milder temperatures and much larger amounts of rain and snow. Their relatively mild winters produce heavy snowfalls, while their summer temperatures

rarely get excessively hot. Mountains farther inland usually display a more *continental climate.* Winters in this type climate are often bitterly cold, while summers can be extremely hot. Annual rain- and snowfall here is far less than in a maritime climate and may be quite scarce for long periods. Relatively shallow snow-packs are normal during a continental climate's winter season.

1-18. Major mountain ranges force air masses and storm systems to drop significant amounts of rain and snow on the windward side of the range. As air masses pass over mountains, the leeward slopes receive far less precipitation than the windward slopes. It is not uncommon for the climate on the windward side of a mountain range to be humid and the climate on the leeward side arid. This phenomenon affects coastal mountains, as well as mountains farther inland. The deepest winter snow-packs will almost always be found on the windward side of mountain ranges. As a result, vegetation and forest characteristics may be markedly different between these two areas. Prevailing winds and storm patterns normally determine the severity of these effects.

1-19. Mountain weather can be erratic, varying from strong winds to calm, and from extreme cold to relative warmth within a short time or a minor shift in locality. The severity and variance of the weather require soldiers to be prepared for alternating periods of heat and cold, as well as conditions ranging from dry to extremely wet. At higher elevations, noticeable temperature differences may exist between sunny and shady areas or between areas exposed to wind and those protected from it. This greatly increases every soldier's clothing load and a unit's overall logistical requirements. Figure 1-4 summarizes the effects of mountain weather discussed below. FM 2-33.201 and FM 3-97.22 contain additional information on how weather affects operations.

TEMPERATURE

1-20. Normally, soldiers encounter a temperature drop of three to five degrees Fahrenheit per 300-meter (1,000-foot) gain in elevation. In an atmosphere containing considerable water vapor, the temperature drops about one degree Fahrenheit for every 100-meter (300-foot) increase. In very dry air, it drops about one degree Fahrenheit for every 50 meters (150 feet). However, on cold, clear, and calm mornings, when a troop movement or climb begins from a valley, soldiers may encounter higher temperatures as they gain elevation. This reversal of the normal situation is called temperature inversion. Additionally, during winter months, the temperature is often higher during a storm than during periods of clear weather. However, the dampness of precipitation and penetration of the wind may still cause soldiers to chill faster. This is compounded by the fact that the cover afforded by vegetation often does not exist above the tree-line. Under these conditions, commanders must weigh the tactical advantage of retaining positions on high ground against seeking shelter and warmth at lower elevations with reduced visibility.

1-21. At high elevations, there may be differences of 40 to 50 degrees Fahrenheit between the temperature in the sun and that in the shade. This is similar in magnitude to the day-to-night temperature fluctuations experienced in some deserts (see FM 3-97.3). Besides permitting rapid heating, the

clear air at high altitudes also results in rapid cooling at night. Consequently, temperatures rise swiftly after sunrise and drop quickly after sunset. Much of the chilled air drains downward so that the differences between day and night temperatures are greater in valleys than on slopes.

Weather Condition	Flat to Moderate Terrain Effects	Added Mountain Effects
Sunshine	• Sunburn • Snow blindness • Temperature differences between sun and shade	• Increased risk of sunburn and snow blindness • Severe, unexpected temperature variations between sun and shade • Avalanches
Wind	• Windchill	• Increased risk and severity of windchill • Blowing debris or driven snow causing reduced visibility • Avalanches
Rain	• Reduced visibility • Cooler temperatures	• Landslides • Flash floods • Avalanches
Snow	• Cold weather injuries • Reduced mobility and visibility • Snow blindness • Blowing snow	• Increased risk and severity of common effects • Avalanches
Storms	• Rain/snow • Reduced visibility • Lightning	• Extended duration and intensity greatly affecting visibility and mobility • Extremely high winds • Avalanches
Fog	• Reduced mobility/visibility	• Increased frequency and duration
Cloudiness	• Reduced visibility	• Greatly decreased visibility at higher elevations

Figure 1-4. Comparison of Weather Effects

WIND

1-22. In high mountains, the ridges and passes are seldom calm. By contrast, strong winds in protected valleys are rare. Normally, wind velocity increases with altitude and is intensified by mountainous terrain. Valley breezes moving up-slope are more common in the morning, while descending mountain breezes are more common in the evening. Wind speed increases when winds are forced over ridges and peaks (orographic lifting), or when they funnel through narrowing mountain valleys, passes, and canyons (Venturi effect). Wind may blow with great force on an exposed mountainside or summit. As wind speed doubles, its force on an object nearly quadruples.

1-23. Mountain winds cause rapid temperature changes and may result in blowing snow, sand, or debris that can impair movement and observation. Commanders should routinely consider the combined cooling effect of ambient temperature and wind (windchill) experienced by their soldiers (see Figure 1-5 on page 1-8). At higher elevations, air is considerably dryer than air at sea level. Due to this increased dryness, soldiers must increase their fluid

intake by approximately one-third. However, equipment will not rust as quickly, and organic matter will decompose more slowly.

WIND SPEED		COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE"																				
KNOTS	MPH	TEMPERATURE (°F)																				
CALM	CALM	40	35	30	25	20	15	10	5	-0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
		EQUIVALENT CHILL TEMPERATURE																				
3-6	5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60	-70
7-10	10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
11-15	15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
16-19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
WINDS ABOVE 40 HAVE LITTLE ADDITIONAL EFFECT		LITTLE DANGER					INCREASING DANGER (Flesh may freeze within 1 minute)						GREAT DANGER (Flesh may freeze within 30 secs)									

Figure 1-5. Windchill Chart

PRECIPITATION

1-24. The rapid rise of air masses over mountains creates distinct local weather patterns. Precipitation in mountains increases with elevation and occurs more often on the windward than on the leeward side of ranges. Maximum cloudiness and precipitation generally occur near 1,800 meters (6,000 feet) elevation in the middle latitudes and at lower levels in the higher latitudes. Usually, a heavily wooded belt marks the zone of maximum precipitation.

Rain and Snow

1-25. Both rain and snow are common in mountainous regions. Rain presents the same challenges as at lower elevations, but snow has a more significant influence on all operations. Depending on the specific region, snow may occur at anytime during the year at elevations above 1,500 meters (5,000 feet). Heavy snowfall greatly increases avalanche hazards and can force changes to previously selected movement routes. In certain regions, the intensity of snowfall may delay major operations for several months. Dry, flat riverbeds may initially seem to be excellent locations for assembly areas and support activities, however, heavy rains and rapidly thawing snow and ice may create flash floods many miles downstream from the actual location of the rain or snow.

Thunderstorms

1-26. Although thunderstorms are local and usually last only a short time, they can impede mountain operations. Interior ranges with continental climates are more conducive to thunderstorms than coastal ranges with maritime climates. In alpine zones, driving snow and sudden wind squalls often accompany thunderstorms. Ridges and peaks become focal points for lightning strikes, and the occurrence of lightning is greater in the summer than the winter. Although statistics do not show lightning to be a major mountaineering hazard, it should not be ignored and soldiers should take normal precautions, such as avoiding summits and ridges, water, and contact with metal objects.

Traveling Storms

1-27. Storms resulting from widespread atmospheric disturbances involve strong winds and heavy precipitation and are the most severe weather condition that occurs in the mountains. If soldiers encounter a traveling storm in alpine zones during winter, they should expect low temperatures, high winds, and blinding snow. These conditions may last several days longer than in the lowlands. Specific conditions vary depending on the path of the storm. However, when colder weather moves in, clearing at high elevations is usually slow.

Fog

1-28. The effects of fog in mountains are much the same as in other terrain. However, because of the topography, fog occurs more frequently in the mountains. The high incidence of fog makes it a significant planning consideration as it restricts visibility and observation complicating reconnaissance and surveillance. However, fog may help facilitate covert operations such as infiltration. Routes in areas with a high occurrence of fog may need to be marked and charted to facilitate passage.

SECTION II – EFFECTS ON PERSONNEL

1-29. The mountain environment is complex and unforgiving of errors. Soldiers conducting operations anywhere, even under the best conditions, become cold, thirsty, tired, and energy-depleted. In the mountains however, they may become paralyzed by cold and thirst and incapacitated due to utter exhaustion. Conditions such as high elevations, rough terrain, and extremely unpredictable weather require leaders and soldiers who have a keen understanding of environmental threats and what to do about them.

1-30. A variety of individual soldier characteristics and environmental conditions influence the type, prevalence, and severity of mountain illnesses and injuries (see Figure 1-6 on page 1-10). Due to combinations of these characteristics and conditions, soldiers often succumb to more than one illness or injury at a time, increasing the danger to life and limb. Three of the most common, cumulative, and subtle factors affecting soldier ability under these variable conditions are nutrition (to include water intake), decreased oxygen due to high altitude, and cold. Preventive measures, early recognition, and

rapid treatment help minimize nonbattle casualties due to these conditions (see Appendix A for detailed information on mountain-specific illnesses and injuries).

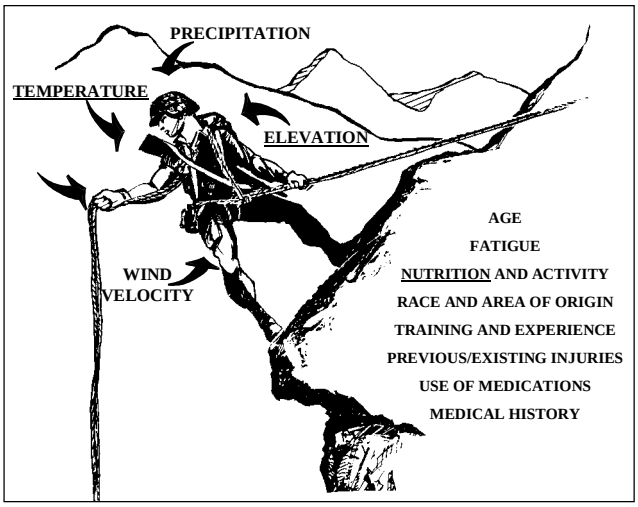

Figure 1-6. Environmental and Soldier Conditions Influencing Mountain Injuries and Illnesses

NUTRITION

1-31. Poor nutrition contributes to illness or injury, decreased performance, poor morale, and susceptibility to cold injuries, and can severely affect military operations. Influences at high altitudes that can affect nutrition include a dulled taste sensation (making food undesirable), nausea, and lack of energy or motivation to prepare or eat meals.

1-32. Caloric requirements increase in the mountains due to both the altitude and the cold. A diet high in fat and carbohydrates is important in helping the body fight the effects of these conditions. Fats provide long-term, slow caloric release, but are often unpalatable to soldiers operating at higher altitudes. Snacking on high-carbohydrate foods is often the best way to maintain the calories necessary to function.

1-33. Products that can seriously impact soldier performance in mountain operations include:

- *Tobacco*. Tobacco smoke interferes with oxygen delivery by reducing the blood's oxygen-carrying capacity. Tobacco smoke in close, confined spaces increases the amounts of carbon monoxide. The irritant effect of tobacco smoke may produce a narrowing of airways, interfering with optimal air movement. Smoking can effectively raise the "physiological altitude" as much as several hundred meters.
- *Alcohol*. Alcohol impairs judgement and perception, depresses respiration, causes dehydration, and increases susceptibility to cold injury.
- *Caffeine*. Caffeine may improve physical and mental performance, but it also causes increased urination (leading to dehydration) and, therefore, should be consumed in moderation.

1-34. Significant body water is lost at higher elevations from rapid breathing, perspiration, and urination. Depending upon level of exertion, each soldier should consume about four to eight quarts of water or other decaffeinated fluids per day in low mountains and may need ten quarts or more per day in high mountains. Thirst is not a good indicator of the amount of water lost,