Chapter 1 : Queen Charlotte Islands Fish-Forestry Project - Province of British Columbia

Canadian Cataloguing in Publication Data Carnation Creek and Queen Charlotte Island Fish/Forestry Workshop (Queen Charlotte City, B.C.) Carnation Creek and Queen Charlotte Island.

Sediment organization and adjustment in a torrential reach of the upper Ijuez river, central Spanish Pyrenees A. Serrano Muela Abstract The dynamics of the torrential upper reach of the Ijuez River, Central Spanish Pyrenees, was analyzed in relation to the spatial organization of grain size. The reach is located in the Eocene flysch, which usually acts as a high sediment production area, particularly during periods of intense human activity. The Ijuez Valley was cultivated and densely populated until the middle of the 20th century, resulting in general deforestation and the development of debris flows, shallow landslides, sheet wash erosion and deep gullies. As a consequence, the alluvial plain became characterized by the presence of large quantities of coarse sediment. The spatial organization of sediment showed a progressive downstream decline in the cobble and boulder size, especially in the channel, whereas the remainder of the alluvial plain showed large variability. No trend in the occurrence of the largest boulders was evident throughout the reach, confirming the importance of debris and hyperconcentrated flows in sediment transport. The torrential reach did not have a negative exponential longitudinal profile, in contrast to that usually observed for mountain rivers. This was attributed to the large quantity of heterometric sediment derived from the hillslopes, which resulted in no marked decline in sediment size and consequent change in the longitudinal profile. A recent trend of scouring was detected, reflecting the reduction in sediment supply following farmland abandonment and reforestation, which have reduced connectivity between the hillslopes and the channel. Keywords torrential reach, debris flows, braided river, channel adjustment, grain size distribution, Central Pyrenees Full Text: Variability of sediment yield from a high mountain catchment, Central Spanish Pyrenees. 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River Research and Applications 21, Factors explaining the spatial distribution of hillslope debris flows. Mountain Research and Development 22 1 , Debris flow characteristics and relationships in the Central Spanish Pyrenees. Natural Hazards and Earth System Sciences 3, Large, historical debris flows in the Central Spanish Pyrenees. Physics and Chemistry of the Earth 22 ,

Chapter 2 : Fish-Forestry Interaction Research - Province of British Columbia

Carnation Creek and Queen Charlotte Islands Fish/Forestry Workshop: applying 20 years of coast research to management solutions.

Abstract Abstract Hierarchical and branching river networks interact with dynamic watershed disturbances, such as fires, storms, and floods, to impose a spatial and temporal organization on the nonuniform distribution of riverine habitats, with consequences for biological diversity and productivity. Abrupt changes in water and sediment flux occur at channel confluences in river networks and trigger changes in channel and floodplain morphology. This observation, when taken in the context of a river network as a population of channels and their confluences, allows the development of testable predictions about how basin size, basin shape, drainage density, and network geometry interact to regulate the spatial distribution of physical diversity in channel and riparian attributes throughout a river basin. The spatial structure of river networks also regulates how stochastic watershed disturbances influence the morphology and ages of fluvial features found at confluences. Principles of fluvial geomorphology have guided the development of much of riverine ecology over the last half-century. A prominent example is the influential river continuum concept RCC; Vannote et al. Based on early principles of fluvial geomorphology e. It predicts gradual adjustments of biota and ecosystem processes in rivers in accordance with the geomorphic perspective of gradual downstream changes in hydrologic and geomorphic properties. The linear perspective embodied in the RCC has dominated river ecology over the last 20 years Fisher , although downstream interruptions in channel and valley morphology, caused by alternating canyons and floodplains, tributary confluences, and landslides, have long been observed. Some have viewed these interruptions simply as adjustments to the original RCC e. In essence, river discontinuum perspectives highlight the nonuniform or patchy distribution of habitats and therefore emphasize habitat heterogeneity, expressed at the scale of meters to kilometers. Such heterogeneity also arises because of the human perception of scale, in which fluvial landforms are hierarchically organized from valley segments to stream bed particles Frissell et al. Consequently, the idea of patchy and multiscale habitat formation and its related heterogeneity has imbued much current thinking in riverine ecology Frissell et al. Riverine ecology has also recognized the importance of physical disturbance e. Just as habitat patches create discontinuities in space, disturbances create discontinuities in time. Concepts emphasizing disturbance or watershed dynamics are generally applied in the context of a particular location within a watershed. However, recent advances in understanding watershed disturbance regimes indicate how disturbance frequency and magnitude are organized by hierarchical and branching river networks Benda and Dunne a , b , Gomi et al. These themes are 1 patchiness or heterogeneity, 2 stochastic disturbance, and 3 hierarchical scaling. This suite of concepts has been used to argue that riverine ecology should be guided by principles of landscape ecology, a discipline that incorporates a similar set of ideas Schlosser The purpose of this article is to develop a geomorphic framework in support of recent advances in river ecology. To create this framework, which we call the network dynamics hypothesis, we developed testable predictions about how the spatial arrangement of tributaries in a river network interacts with stochastic watershed processes to influence spatiotemporal patterns of habitat heterogeneity. We begin with a general review of how tributary confluences modify channel morphology. Next, we describe how stochastic watershed disturbances such as floods, fire, and storms impose temporal heterogeneity on confluence effects, but in a predictable fashion that reflects the controls exerted by the underlying network structure. Finally, we consider how the general principles developed in our hypothesis could advance the coupled disciplines of geomorphology and riverine biology. Effects of tributary confluences on channel and valley morphology By definition, a tributary is the smaller of two intersecting channels, and the larger is the main stem. Strictly speaking, a tributary junction, or confluence, is defined as the point where two different streams meet. In the broader definition used in this article, a tributary junction is the valley floor environment influenced by tributaries and may include alluvial fans, terraces, secondary channels, and wider floodplains.

The numerous bifurcations and confluences of distributaries in braided channel systems are not covered here. Three main types of processes are responsible for transporting sediment and organic material down tributaries to confluences with the main stem. Debris flows transport an unsorted mixture of sediment including boulders and logs and often create erosion-resistant deposits; normal runoff floods transport bed load and suspended load and create stratified alluvial deposits; and flash floods transport extremely high sediment loads and create deposits intermediate between debris flows and runoff floods. These sediment transport processes often create depositional fans where tributary channels enter lower-gradient and wider channels or valleys Bull The interaction of two independent sediment transport regimes at channel junctions can produce dramatic changes on the receiving channel and valley floor see table 1 for a listing of these effects. Morphological effects at confluences, including formation of fans, may be transient or persistent, depending on the rate at which organic material and sediment are transported to tributary junctions and moved by receiving channels. Sediment deposits that form at junctions can impose a topographic impediment to the main channel, often locally constricting valley width and displacing the main channel across the valley floor figure 2. These topographic effects induce certain morphologic responses in main stem channels, such as a localized flattening of the channel gradient upstream and a corresponding steepening of the gradient downstream figure 2. Gradient-induced longitudinal variations in sediment transport rate in the vicinity of junctions cause upstream reductions in substrate size, increases in channel meandering, and increases in floodplain and terrace width. These changes are offset by other tendencies on the downstream side of the junction, including coarser substrates and increases in channel width, pool depth, and occurrence of bars. The same general classes of channel changes occur at confluences regardless of their location in the river network see table 1 , although certain types of changes, such as boulder accumulations leading to rapids, occur predominantly near debris flow or flash flood deposits. The morphological conditions near channel junctions differ from those in reaches located upstream or downstream; confluences are agents of habitat formation and increased morphological heterogeneity figure 2 ; Rice et al. In this article, we concentrate on the morphological effects at junctions linked to tributary sources of sediment and wood, although our analysis of the influences of river network geometry should also apply to more flow-related changes in morphology at junctions in less erosion-prone landscapes e. Effects of river networks on the structure of riverine habitats The physical structure of river networks can be defined by basin size, basin shape, network pattern, size difference between confluent channels, the power law of stream sizes e. Our predictions about how river network structure influences spatial patterns of confluence-related morphology box 1 apply to a range of channel changes e. We also predict local changes in heterogeneity at confluences, which will usually increase. Heterogeneity is defined by the type, form, and age distribution of fluvial landforms. It is not yet possible to develop quantitative predictions about specific morphological changes at confluences because of the low resolution of data e. The role of basin size. Consistent flow-related morphological changes i. We postulate that morphological effects caused by punctuated inputs of sediment and wood at confluences will also scale to the size of the tributary relative to the main stem. We anticipate this result because larger basins typically produce larger quantities of sediment, and because larger tributaries generally have larger fans associated with them Bull Moreover, larger and more powerful rivers are more effective at removing tributary inputs of sediment Benda et al. To evaluate this expectation, we analyzed the results of 14 published field studies that document a range of confluence effects in 19 streams and rivers, caused by the abrupt introduction of sediment and wood see table 1 for a listing of these effects. These data reveal that as the size of the main stem increases, geomorphically significant confluences are associated with increasingly larger tributaries figure 3. For example, debris flows that originate from small basins up to 1 km2 in drainage area create tributary-junction effects in basins of only 1 to 50 km2. By contrast, tributary-junction effects in larger rivers to , km2 are associated with larger tributaries 10 to 10, km2. The data in figure 3 also reveal a threshold below which tributary basins less than approximately 1 km2 do not affect main stem rivers larger than approximately 50 km2. This finding has important ramifications for the increased downstream spacing of confluence effects as the size of the main stem increases. The variability of the data in figure 3 is probably due to factors such as basin geology e. Temporal variation in the history of storms, fires, and floods that create or rejuvenate confluence effects should also cause the waxing and waning of confluence effects. A more detailed analysis of the data in figure 3 allows for probabilistic predictions of confluence effects Benda et al. For example, in humid environments, a range of 0. The role of network pattern and basin shape. The scaling relationship between tributaries and main stem channels figure 3 allows us to consider how the factors that control the spatial distribution of tributary sizes in river networks influence spatial patterns of confluence-related morphology and heterogeneity. Downstream trends in junction effects are influenced by network patterns and hence by drainage basin shape. Two common types of network patterns are dendritic and trellis networks. Dendritic networks, which resemble the hierarchical branching pattern of a tree, often form in homogeneous and gently sloped geologic beds and create heart-shaped or pear-shaped basins. In contrast, trellis networks, characterized by small tributaries intersecting main stem channels, are often associated with elongate landforms in dipped and folded sedimentary rocks or in areas of parallel fractures; they create narrow, rectangular basins. The spatial configuration of tributaries within a watershed changes the likelihood of confluence effects downstream in river networks. Since larger tributaries are required to create geomorphic effects as the size of the main stem increases e. These effects occur because increasing the basin width downstream promotes the coalescing of hierarchically branched channels, resulting in larger tributaries forming downstream. In contrast, narrow, rectangular basins containing trellis networks lack the formation of larger tributaries and therefore discourage confluence effects as main stem size increases. Consequently, network configuration related to basin shape should strongly influence the downstream sequence of confluence effects figure 4 ; see also the testable predictions in box 1. In addition to dendritic and trellis networks, other network types include parallel networks, which form in conjunction with parallel landforms, and rectangular networks, which form where numerous faults and joints converge at high angles. Region-specific types of geology and hillslope topography should influence network patterns and hence the spatial distribution of confluence-related channel morphology and associated physical heterogeneity. For example, the young and porous rocks of the high Cascade Mountains in Oregon are characterized by trellis networks, while older and less permeable rocks nearby exhibit dendritic networks Grant Drainage density and confluence density. The cumulative effect of confluences within a basin should be proportional to the total number of geomorphically significant channel confluences. This number is related to drainage density defined as channel length per unit watershed area and to network shape, which either promotes or inhibits the occurrence of confluent channels see figure 5. The corresponding confluence density the number of geomorphically significant confluences, per unit area or per unit channel length should provide a simple measure of the net morphological effect of confluences in rivers box 1. Drainage densities in humid to semiarid landscapes range from 2 to 12 km channel length per square kilometer watershed area, primarily reflecting variations in precipitation, landscape age, and bedrock porosity Grant This large range in drainage density translates to a correspondingly large range in the density of channel confluences, with implications for the degree of channel heterogeneity found in different landscapes figure 5. Local network geometry can be used to describe the kilometer-scale variation of tributary effects in rivers, including the longitudinal sequence of tributaryâ€”main stem size ratios figures 3 , 4 , tributary intersection angles, and distance between geomorphically significant confluences figure 1d. The tributaryâ€”main stem intersection angle is the upstream angle formed at a confluence. For instance, in a series of river studies and in flume experiments, Mosley and Best showed how bar size, bar location, and scour depth vary with confluence angle.

Chapter 3 : Forestry Handbook for British Columbia Part 1 by UBC Faculty of Forestry - Issuu

Carnation Creek and Queen Charlotte Islands Fish/Forestry Workshop: Applying 20 years of coast research to management solutions (Land management handbook) Hardcover - Be the first to review this item.

The impacts of riparian forest harvesting on the sediment regime of streams are of concern because of extensive commercial use of forest resources in BC. Forestry practices can alter the natural sediment balance and lead to abnormally high rates of sediment input resulting in increased concentrations of sediment in the water body and increased deposition of sediment on the stream bottom. The increase of sediment yield driven by forestry operations can reduce the storage capacity of reservoirs and degrade the water quality for human drinking, industrial, and recreational uses. Sediment inputs that exceed the background level and turbidity can also increase the risk to the survival and the integrity of aquatic ecosystems. Riparian forested areas in both coastal and interior plateau forest watersheds need careful considerations of riparian buffers and best management practices to avoid excessive sediment delivery into stream networks. Also, quantitative studies need to be conducted to compare different harvesting methods and provide forest management planner better suggestions to achieve both economic and environmental objectives. In general, a holistic approach is required to control sediment production across different landscapes. I List of Acronyms and Abbreviations III List of Figures IV List of Tables Coastal and Central Interior BC Sediment cycle in forest watershed Ministry of Environment RMA: Regions of British Columbia. British Columbia Forest Land Map: North Central Interior Region South Central Interior Region Sediment supply, transport and deposition in forested watershed with moderate slope.. Sediment transfer processes in steep forested watershed Cross section and features of a typical cut-and-fill logging road Summary of primary sediment sources and the corresponding importance The levels of risk and corresponding sediment concentration In the Province of British Columbia BC , the impacts of riparian forest harvesting on the sediment regime of streams are of concern because of extensive commercial use of forest resources Jordan, Forest operations remove ground vegetation and disturb forest soils resulting in an increased risk of soil erosion. Therefore, soil erosion caused by riparian forest harvesting will potentially add unusually large amounts of sediment to the water body, thereby significantly affecting stream physical, chemical and biological process Birtwell, Natural sediment inputs were controlled by local climate, soil conditions, native vegetation types, and watershed characteristics. A stream can be considered to be unnaturally or excessively impacted by sediment when human activities are contributing sediments Environment Canada, Forestry activities such as road construction and timber harvesting may increase sediment yield, but the implementation of best forest management and riparian area protection practices can effectively stabilize stream banks and intercept sediments. Overall, the impacts of riparian forest harvesting on stream sedimentation are complex and may vary depending on the geographical locations, climate features, hydrological regime, watershed characteristics and logging methods. The study areas of this literature review will be focused on watersheds located in the coastal and interior plateau regions of BC because the majority of watershed studies related to logging and sediment interaction were conducted in these two areas. There are some differences in hydrological regimes, stream networks, forest types and harvesting systems between coastal and central interior forested watersheds. Thereby, it is likely to see how forest harvesting activities differently affect sediment dynamics between these two areas. Also, previous studies evaluating the impacts of forestry and sedimentation interaction in the coastal and central interior forest watersheds will be discussed as well. Excessive sedimentation after logging activities can come in the form of both suspended and bedload sediments Turner, Increases in sediment flux can be demonstrated as both high suspended sediment concentrations in the waterbody and increased sedimentation of streambed substrates. Other adverse impacts include reducing the storage capacity of reservoirs, destroying wetland areas, and degrading the water quality for human drinking, industrial, and recreational uses Turner, Stream sedimentation issues resulting from poor forestry practices are prevalent in BC and affects both spawning and rearing habitat for salmonids, and their aquatic food chain Larkin et al. Increased suspended sediments reduce water clarity and decrease the penetration of light into the water, then affecting fish and invertebrate species foraging activities. Increased concentration of inorganic sediment in the stream can also impair biological functions for benthic communities. Benthic invertebrates including numerous species of insects, molluscs and crustaceans are highly dependent on their surroundings. In this essay, coastal and central interior plateau forest watersheds are the main study areas and this section provides the background information of geographic features, climate, hydrological regimes and forest covers. Coastal mountain areas support temperate rainforests under a maritime climate, and there are extensive snow and ice cover at higher elevations. The forests have been heavily exploited for their valuable timber resources in this region since the s. There are diverse topographical features in the coastal area including coastal lowlands and broad alluvial valley bottoms associated with major rivers, e. Fraser River is the largest river systems in BC and is important to the salmon fishing industry. The stream and lake networks within coastal forests have valuable fish populations, especially the Pacific Salmon Oncorhynchus spp. Coastal Forest Region is also well recognized as temperate rainforest Slaymaker, which includes two primary biogeoclimatic zones BEC: This area covers the northern half of the Fraser River watershed and includes Smithers and the Bulkley Valley on the west part Figure 3. Forestry has been the most important industry since the middle s when a pulp mill was established in Kamloops as well as sawmills and other forest 6 product manufacturing plants sprang up throughout the region McGillivray, Interior spruce forest region includes two primary BEC zones: Thus, the cooler and drier Interior forest region are home to more trees of the pine and spruce variety. Sediment cycle in forest watershed A knowledge of sediment dynamics is helpful to understand the riparian logging and stream sedimentation interaction. The sediment cycle Figure 5 starts with the process of weathering, i. The transportation process initiates from the land surface, then gullies, hillslopes Figure 6 , logging roads act as the functional pathways for sediment delivery. Water plays a major role in the transformation of the Canadian landscape by moving large amounts of soil, in the form 7 of sediment Environment Canada, The flows of water are the main carrier for in-channel sediment transportation, and forestry operations like logging and road construction have significant impacts on watershed hydrological characteristics. Thus, the erosion process caused by increased stream flow may take place much faster. As mentioned before, stream flow supports the transportation of suspended sediments in the water body. However, the bedload transport which refers to the movement of particles or grains along the stream bed was supported by the bed itself Hickin, Bedload sediments are largely consisting of sand 0. Thus, bedload movement in many streams is uncommon or negligible at low flow but the transport can be active when stream discharge increases and exceeds critical shear stress Hickin, Besides, changes in bedload movement and stream bank erosion caused by peak flow increases following logging practice can provide an additional source of suspended sediment Jordan, In steep forested area Figure 6 , hillslope process which include surface erosion and debris flow plays a significant role in sediment transport down slopes and into channels. Deposition or sediment storage is the final process in the cycle. Sediment carried by stream flow will ultimately settle to the bottom as water velocity decreases and loses transport energy Ministry of Environment, Excessive sediment deposition on streambeds can alter stream hydrological processes and degrade streambed quality Kreutzweiser et al. Primary sediment sources 4. Logging practices such as landing, road constructions, and skidding trails may significantly increase soil compaction, reduce soil productivity and accelerates soil erosion. Besides, forest harvesting and road development can improve the delivery of water to soil and streams, resulting in acceleration of soil disturbance and initiation of debris torrents then making sediment becomes more available to the stream networks Slaymaker, Table 1 describes the main sediment sources that were collected from previous forest watershed studies in coastal and interior BC. Soil compaction refers to the process of increasing soil density by packing the particles closer together and reducing pore space, and resulting in reducing soil porosity decreasing water movement into and through the soil McLellan, Rutting happens especially under wet conditions when the soil strength is too weak to support pressure from operating machinery e. Rutting can affect the surface runoff and reduce water infiltration then increasing soil saturation and creating soil erosion Grigal, Puddling process can alter soil properties as shearing forces can affect soil structure and porosity, then can lead to soil compaction and erosion Grigal, Wet, fine-textured soils are more susceptible to puddling than coarse soils, so avoiding harvesting on wet conditions is the best approach to prevent puddling impacts McLellan, Reduced soil infiltration rates, increased slopes, removal of vegetation cover and interception of subsurface flow are several major factors that result in increased erosion potential of forest roads. All of these factors can also contribute to sediment transportation as a result of increasing the volume or the velocity of storm runoff Grace, 10 But, rainsplash, road surface textures and operational activities e. Some of sediment sources from roads might include delivery from road fills, long unvegetated road fills, unstable unvegetated cutslopes, soil erosion at crossing structures and road sections with steep slope nearby stream networks Berry, Road crossings structures, particularly culverts can impede the water movement, sediments and fish activities in streams. For example, perched or blocked culverts can cause sediment or debris accumulations below them that blocked fish movements upstream Tschaplinski, In particular, unpaved roads can increase sediment production rates by more than an order of magnitude as a result of road surface erosion. According to the results of assessment of the effects of roads on the post-harvesting condition of streams in both coastal and interior BC Tschaplinski, , forest roads were identified to be the most frequent cause of impacts to streams as two-thirds of total of total sample streams impacted area were affected by inorganic sediments generated and delivered by roads. Nevertheless, not all eroded materials from road surfaces can reach the receiving water due to deposition process between the sediment initiation location, crossing structures e. Figure 6 shows surface flow is usually drained to ditches on the side of the road and then can be redirected by culverts. Landslides and debris flow occur when gravitational forces and hydrologic conditions exceed the strength of the soil Jordan et al. Hillslope failure, particularly in steep terrain, is a significant source of sediment to streams. Even in the absence of forestry, shallow debris slides and flows are especially common on the coastal region while large rotational rock movements are common in glacial sediments and volcanic bedrock in the interior BC Geertsema et al. Debris slides are the simplest and prominent landslide type in BC and debris flow is a form of mass movement of saturated soil, rocks and vegetation. Nevertheless, forest harvesting practice indeed plays a significant role of accelerating hillslope failure process, especially in BC coastal forest watersheds Jordan et al. In south interior Redfish Creek region, five landslide events happened from logging roads during and the estimated average sediment delivery to the 12 creek is 25 tonnes per year Jordan, , but in most years, landslides contribute no sediment in this region which means the contribution of sediment from landslide events is a risk. Landslide hazards are high in gully areas where steep slopes and drainage can interact with each other, resulting in debris slides. Debris slides initiated debris flows due to contribution of channel water are common in BC watersheds Geertsema et al. The volume of sediment delivery is greatest from torrent and slash disturbed gullies by mass wasting and fluvial channel erosion, particularly in coastal watersheds Slaymaker, Both of these non-integrated forest management practices are the main factors for road-related slope failures. Results and Discussion 5. The results showed that landslides and erosion have produced a fold increase in sediment production from timber harvesting in BC mountain areas. Besides, debris flows and unpaved logging roads are the most significant contributors to sediment production Slaymaker, Up-slope or streamside falling and yarding which are common logging practices in coastal forests can influence soil stability more exposure and compaction , sediment supply and delivery to the stream.

Chapter 4 : Fishes and forestry : worldwide watershed interactions and management in SearchWorks catal

The Carnation Creek experimental watershed project The Queen Charlotte Islands Fish-Forestry Interaction Program Application and extension of Carnation Creek and Queen Charlotte Islands results.

An introductory overview of fish-forestry interactions T. Ecology of the Systems. Elements of stream ecosystem process G. Fundamentals of lake ecology relevant to fish-forestry interactions T. Fundamental aspects of estuarine ecology relevant to fish-forestry interactions T. Fish Biology and Ecology. Fish life history variation and stock diversity in forested watersheds T. Fish migration and passage in forested watersheds T. Aspects of fish reproduction and some implications of forestry activities G. Forest harvest and transportation P. Manufacturing Processes and their impact on effluent discharges N. Forestry Effects on Aquatic Systems and Fishes. Effects of Forestry on the limnology and fishes of lakes T. Effects of forestry on estuarine ecosystems supporting fishes C. Environmental effects of Effluents from pulp and paper mills K. North American Fish-Forestry Interactions. Forestry and Fish in the boreal region of Canada R. Fish-forestry interactions in freshwaters of Atlantic Canada R. Non-north American Fish-Forestry Interactions. Fishes-forestry interactions in tropical South America C. Europe - with special reference to Scandiniavia and the British Isles D. Freshwater fishes and forests in Japan M. Fish-forest harvesting interactions in perhumid and monsoonal southeast Asia Sundaland J. Regional case studied in fish-forest harvesting interactions: Malaysian and Indonesian Borneo and Cambodia J. Forestry interactions - New Zealand B. Effecting Better Fish-Forestry Interactions. Guidelines, Codes and Legislation K. Forest Management and watershed restoration: Better and broader professional, worker and public education in fish-forestry interaction T. The interactions between fishes and forests are complex, multifaceted, dynamic processes involving most inland surface waters, forests, subsurface waters, geology and soils, climate and its changes, and the biotic components of the relevant ecosystems. These interactions also include the aspects of forestry tied to human development, economics, population growth and even philosophies. The editors, Professors Northcote and Hartman, have drawn together and carefully edited chapters written by 56 scientists from around the world, covering a vast wealth of information never before appearing within the covers of one book. Following an introductory chapter, this exceptional work is broadly divided into sections covering: Libraries in all universities and research establishments where these subjects are studied and taught should have several copies on their shelves. Nielsen Book Data Subjects.