ASPECT

Definition: `as – pekt / 1. a position facing a particular direction
2. appearance to the eye & mind.

THE DEGIFS NEWSLETTER

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The "Editorial"

"What a summer", an understatement to say the least. Besides having Uncle Sam hammer us with continued softwood import duties and then go "off the deep end" because of one Albertan "mad cow", we had the SARS scare, continued bark beetle infestation, and Mother Nature ("Person Nature" for the politically correct) throwing us one of her time/space climatic blips. For southern BC at least, - hot and dry conditions - a Heaven for some and pure Hell for others.

Pontificating from a Lower Mainland window, viewing parched lawns and wilted bushes (you guessed it, I'm not in West Van.), having only taken one short shower - on recommendation from leader Gordon - and with no water including ice in the libation (have to do ones part to for local water conservation) I pondered, "yep, its dry" - the weather that is. However, despite a local hype of lack of water (there is no lack of water, just a problem of distribution of water), the issue is insignificant as others in the Province are looking at and/or experiencing far more significant and larger disasters.

This dry spell has certainly has its effects. Most noticeable being forest fires with resulting resource and infrastructure loss, woods closures, mill shutdowns, property destruction, income loss, social and economic stress, the list goes on. A vicious wave of interrelated cause and effect events that impacts everyone in the Province, albeit in different ways. However, using an ocean wave as an analogy, a wave tends to be temporal and spatial in both form and event, it eventually breaks to dissipate energy and in the process creates and enhances local opportunities and environments. It is these opportunities and environments that are important. This is where the skill and knowledge sets that you and your compatriots have and are needed to assist with renewal of resources, in growth, infrastructure and management. Kudos to all those involved directly and indirectly with the forest fires and strength to those who have experienced loss. Keep up the good work and strength, you do make a difference.

We wish to remind all DEGIFS members to become appraised of the proposed APEGBC fee increase bylaw and to take the appropriate action of their choice. Your Association is only as good as you make it, so please keep yourself informed and have input.

The "Ed."

EDITOR'S EDITION: Aspect is pleased to announce a 'fast and furious' edition to the crew. On Sep/7/03 Jennifer Clarke gave birth to Natasha (10lb 2oz!!). Welcome to the outside Natasha. Please let mom get some sleep!

DIVISION OF ENGINEERS AND GEOSCIENTISTS IN THE FOREST SECTOR
Volume 8, No. 3 **SEPTEMBER 2003**

EXECUTIVE UPDATE
Eric McQuarrie, P.Eng., DEGIFS Chair

Following up on last issue's Executive Update, your executive's efforts over the summer has generally focused on the preparation of guidelines for both bridge design and terrain stability assessment. Our involvement in each is vastly different.

Bridge Design Guidelines

The Joint Practices Board is currently preparing guidelines for forest road bridge design. This is a JPB document; therefore, DEGIFS' involvement has been limited to the APEGBC members on the JPB. DEGIFS had two members who are bridge designers attend the last JPB meeting to discuss and provide advice on the guidelines. We are currently awaiting the release of the draft guidelines for our review and comments. Although our involvement in preparing this document has been quite limited, we will have ample opportunity to shape this document before it is finalized.

Some DEGIFS members view forest road bridge design as solely the right of practice of professional engineers and the definition of "practice of professional engineering" in the current Engineers and Geoscientists Act certainly includes bridge design. However, the Association of BC Professional Foresters (ABCPF) interprets the definition of the "practice of professional forestry" in the recently revised Foresters Act as also including this right of practice. In the past, the forest road regulations specified who was permitted to design bridges under what conditions. The recent changes to the regulations have eliminated many of these divisions of practice, leaving it to the respective professional acts to address. As a result, the JPB are trying to sort out the divisions of practice with these guidelines.

The approach taken by the JPB appears to be to define the skills sets required to design bridges under specific conditions. These specific conditions, we understand, will include various risk factors. The JPB's argument is that provided the bridge designer has the appropriate skills set to design the bridge, the professional designation is secondary. Your DEGIFS executive is divided on this issue (and have had some lively debates). Our review and subsequent discussions will likely focus on this argument as well as the suitability of the skills sets.

Your executive is taking this issue very seriously and will be relying on several bridge designers outside of the current executive to assist in reviewing these guidelines. If you are an active bridge designer (and a member of DEGIFS) and interested in assisting us during our review, or if you have a strong opinion on this topic, please contact the executive.

Terrain Stability Assessment Guidelines

DEGIFS' greatest task over the summer has been completing the "Guidelines for Terrain Stability Assessments in the Forest Sector." Last issue's *Executive Update* included a brief summary of the intent of the guidelines. This is an APEGBC / DEGIFS document that has involved many members during the various stages of writing and reviewing.

The guidelines recently underwent external review by the Ministry of Forests, the JPB, and the ABCPF (the BC Institute of Agrologists were invited but did not respond). Based on the comments received, we are completing the final document for submission to the APEGBC Professional Practice Committee in September. Hopefully, the guidelines will be approved and adopted by APEGBC Council in October. After publication, the document will be available through either the DEGIFS or APEGBC websites. A brief summary of the document will be presented during the DEGIFS technical sessions at the AGM in Penticton.

A side issue: when first assembled, the committee had only two sitting members of the executive. The objective was to involve members from outside the executive; however, three of the committee members were subsequently elected to the executive in 2002. The lesson being: the easiest way to get involved with DEGIFS is to volunteer for one of the committees (or maybe it's if you don't want to get elected to the executive, don't volunteer for a committee – either way, it's a good lesson).

I hope you are planning to attend the 2 days of technical talks and the field trip planned at the AGM in Penticton. The talks are more technical and less administrative than in the past, providing great value for all who attend. See you there.

FOREST PRACTICES CODE CHANGES TO REGULATIONS

Eric McQuarrie, P.Eng., DEGIFS Chair
Commentary

A number of changes were made to the Forest Practices Code during the spring and summer of 2003. The changes affect: Planning, Silviculture, Harvesting, and Roads. These changes are summarized in the document called Highlights #10 available at: http://www.for.gov.bc.ca/HFD/TRAINING/FPCtrain/Highlights/index.htm

DEGIFS members should refer to this website for more complete description of the numerous changes to the regulations. Upon review of these highlights, the changes most likely to affect DEGIFS members are summarized below.

Road Layout and Design

FRR 5.1 has been amended and FRR sections 6 and 7 have been repealed. This is the "least likelihood" issue that frustrated many DEGIFS members. Previously, if a person planned to construct a road on unstable or potentially unstable terrain using techniques that did not have the "least likelihood of landslides", they would first need to submit a road layout and design for approval by the district manager. Now, this has been clarified to require that a design must be submitted for approval if the likelihood of a landslide occurring is greater than 'low'.

Professional Reliance

The *Foresters Act* and *Agrologists Ac*t have been amended. The new Acts "strengthens the ability of those professions to enforce their acts. The changes also will equip associations with stronger capacity to sanction poor practitioners. A lack of diligence can lead to sanction of a professional by their respective associations."

The *College of Applied Biology Act* was brought into force by regulation. "This new act gives professional biologists the same recognition and responsibilities as enjoyed by professional agrologists."

WHAT EVERY GEOSCIENTIST NEEDS TO KNOW ABOUT ROAD GENERATED SEDIMENT (but were too busy inspecting slope failures to ask)

Brian Carson, P.Geo.[1] and Mike Younie, P.Geo.[2]

We geoscientists practising in B.C. focus on the hazards of, and risks associated with catastrophic mass failures. There is nothing like a major debris torrent or massive landslide to get our attention! Assessment of possible loss of life and property is our primary concern and we do rather well at these assessments. Once those aspects of risks are covered, we then assess potential degradation of the environment including fisheries and water quality- unfortunately we are less proficient with these assessments. Usually, once we determine that sediment will reach a river, we believe we have done our job. In this complex, litigious age, this may not be enough.

While the authors are also caught up in the excitement of major earth shaping events, they have come to appreciate that the mass-failure-focus of geoscientists may cloud our judgement. Sometimes, slow but insidious soil erosion associated with road surfaces, ditches and culvert outfalls, can be a major cause of water quality degradation in surface water supplies causing great consternation with our clients. Especially since the Walkerton fiasco, watershed managers have been asking themselves whether they are doing everything they can to provide the best quality water possible to the public. We, as Geoscientists with our bag of tricks, should be key players in this assessment. Ask yourself, "Are we providing the weighted assessment of risks from all sources of sediment that the watershed managers need to make good decisions or are we simply responding to a client's legal obligations with one specific activity?" The answer to the former is rarely yes but more than likely yes to the latter.

Geoscientists are frequently asked to inspect new road locations and determine risks and how they might be mitigated. This is an important contribution. However, to determine how to manage road induced sedimentation, one should weigh all existing sediment sources and apply our collective knowledge to get the best value from a sediment control budget. A limited sediment control budget in a community watershed should be spent where it maximizes improvement of water quality. Have we being doing this? We all know that lots of money has been spent in watershed rehabilitation stabilizing road prisms that would otherwise collapse harmlessly onto slopes below and re-establish vegetation on slopes that do not present a major risk to water quality. Conversely, we know that ditches carrying road concentrated drainage can generate huge sediment loads as they cut into slopes on their journey to meet natural drainage. We are usually quick to subscribe settling ponds for sediment removal but are we actually removing the sediments of concern to water engineers (silts and clays) or are we compounding problems by brewing a mess of organic soup within those settling ponds? Part of our professional assessment should include a more holistic cost effective treatment of road induced sedimentation as it affects the water purveyor. If we can do this, we are truly engaged in "Results Based Management".

The amount of erosion occurring on or adjacent to a road segment does not necessarily relate well to downstream water quality degradation and does not necessarily require the implementation of Best Management Practices. The best way to estimate the sediment loading potential of a road segment requires assessment of three conditions concurrently.

- the potential for fine sediment generation of a road segment
- the potential for the road to concentrate surface and subsurface water and,
- transport pathway between road drainage and natural drainage.

A road can be built on fine textured materials in the absence of concentrated water for without water to transport it, there can be no sedimentation. Should road drainage and natural drainage be interconnected, then even a small amount of road generated sediment may be of concern. By weighing the relative importance of these three conditions for road segments within a watershed, one can provide a rational basis for how to better manage sediment generation. Employing Best Management Practices for a road segment become mandatory when all three conditions are met simultaneously and there is a credible downstream concern.

Using these criteria, some mass failures can be considerably less important to watershed managers, than an apparently benign road segment upstream of a water intake.

The interactive CD entitled ***Results Based Forest Road Management to Maintain Water Quality in Coastal Watersheds*** looks at a wide range of road situations on coastal BC and provides some insights into the assessment of the importance of road generated sediment to water quality engineers. This CD is available, free of charge to those involved with designing, constructing and maintaining forest roads. Anyone interested in obtaining a copy of the CD should contact the authors, Brian or Mike at the following addresses:

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[2] Mike Younie, Senior Ecosystem Specialist, Ministry of Water, Land and Air Protection, 2nd Floor-10470 152nd Street, Surrey, BC, V3R 0Y3. Phone: (604) 582-5391 Email: Mike.Younie@gems8.gov.bc.ca

NEWS FROM THE INSTITUTE (FMIBC), Summer 2003

FMIBC Board of Directors

Forest Management Institute of British Columbia

Summer 2003

Dear FMIBC supporter:

The Forest Management Institute of BC (FMIBC) was established in 1985 to offer advanced continuing education programs to the forestry community. We have fulfilled our mandate for 18 years, and have met our goal of improving forest practices in BC by educating key forestry professionals and practitioners.

We believe that the broad community of forestry professionals and practitioners continues to support our programs in silviculture and forest engineering:

- *UBC Diploma in Forestry (Advanced Silviculture)*
- *UBC Diploma in Forest Engineering*
- *Silviculture Technical Program.*

FMIBC remains committed to the delivery of these high quality programs and is currently exploring interest for a new professional program in **Sustainable Forest**

Management. Despite our favourable long-term outlook, the Board of Directors has chosen to move the Institute to a reduced operations model over the next six to twelve months. This decision is driven by several factors:

- recent enrollment has been suppressed by a combination of excessive demands placed on the forest sector and profession
- funding support for development of our proposed new program in Sustainable Forest Management has not yet been secured
- protection of our positive financial position.

During this period of reduced operations, the Board will continue to study the demand for our existing and proposed curriculum. It is also our belief that the success of continuing education and extension initiatives for forest industry professionals will require improved coordination among the various delivery organizations and financial supporters. The Board intends to be fully engaged in exploring new models for delivery of continuing education and extension in BC during this period of reduced activity.

FMIBC will retain its Board of Directors, website, main telephone line and email address during this period. In addition, we will continue delivery of outstanding modules for our active students. Please visit our website *(www.fmibc.org)* often for updates on the status of our programs and make a note of our contact information, **effective August 1st:**

Mailing address:	2665 East Mall, Vancouver BC V6T 1W5
Telephone number:	604-224-7800 (Call to make arrangements to send a fax)
Email:	execdir@fmibc.org
Website:	www.fmibc.org
Contact:	Candace Parsons, RPF

We hope to be in touch with you again soon!

Yours truly,
The FMIBC Board of Directors

Reid Carter, RPF, Chair
Warren Mitchell, RPF, RPBio, Vice Chair
Alex Sinclair, PEng, Sec-Treasurer
Don Dobson, PEng, Past Chair
Ralph Archibald, Director
Dr. Gordon Baskerville, Director
Jonathan Fannin, PEng, Director
Gordon Weetman, RPF, PhD, Director

FMIBC 2003 Graduate Announcement
UBC Diploma in Forest Engineering

These foresters, engineers and geoscientists have completed 6 modules of intensive forest engineering education. Congratulations to them all!

Calvin Bigelow RPF
Canadian Forest Products Ltd, Prince George

Ron Donnelly RPF
Ministry of Forests, Smithers

Peter Egyir PEng
Ministry of Forests, Prince George

Chris Elden RPF
Consultant, Quesnel

Norm Fennell RPF
Tolko Industries Ltd, Louis Creek

Richard Johnson RPF
Ministry of Forests, Queen Charlotte City

Colin Johnston RPF
Canadian Forest Products Ltd, Houston

Tracey Jones PEng
Ministry of Forests, Prince George

Frank Kaempf RPF
Riverside Forest Products, Williams Lake

Brian Mallett PEng
Ministry of Forests, Revelstoke

Greg Mowatt RPF
Pope & Talbot Ltd, Midway

Les Thiessen PEng
Ministry of Forests, Nelson

Michael Van Arem RPF
Canadian Forest Products Ltd, Houston

Irene Weiland PGeo
Weiland Terrain Sciences, Smithers

Further congratulations to Michael Van Arem - this year's top student!

2003 DEGIFS BURSARY RECIPIENTS: Research Summary Papers

As noted in the July 2003 issue of Aspect, Derek Kinakin and Mihai Pavel are the successful recipients of the 2003 DEGIFS Bursaries. The following two articles are papers submitted by both students. The papers summarize their research and are a required component of the DEGIFS bursary application. Congratulations to both Derek and Mihai !

The Confusion of Root "Cohesion"

Derek Kinakin, M.Sc. Candidate
Terrain Analysis and Forestry Geotechnics
Earth Sciences Department, Simon Fraser University

Introduction

The role of tree roots in regards to the stability of natural slopes has been intensely studied. Many researchers have shown evidence that the removal of roots (often by dying) leads to an increase in the frequency of landslides (Ziemer and Swanston, 1977, Schmidt et. al, 2001). The increase in landslide is thought to be linked to the hydraulic and mechanical changes in the soil due to the loss of roots (Greenway, 1987). Attempts to quantify the amount of mechanical support that tree roots add to the soil slope have returned mixed results. Many studies have been completed reviewing the physics behind how roots add strength to the slope (Wu et al., 1979, Wu et al. 1988a, Wu et al. 1988b, Wu and Watson, 1998). However, some field practitioners remain unclear of how to factor root reinforcement into their slope stability estimates. Three modes of mechanical reinforcement will be reviewed: apparent cohesion, vertical anchoring and lateral support. The implications of these soil reinforcements on slope stability estimates will be briefly examined.

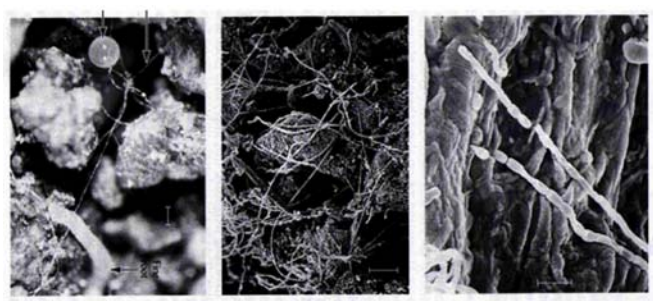
The Roles of Roots

i) Apparent Cohesion

Although many researchers refer to the additional cohesion that roots provide to the soil, only a small portion of the roots actually behave in a cohesive manner. Cohesion describes the inter-particle attraction most often caused by weak electro-static forces between particles (true cohesion) or suction forces (an apparent cohesion) in the particle matrix (Brady and Weil 1999). Soils with high percentages of clays and organic particles often show some limited cohesive strength. Aggregate particles or soil peds form in these soils because of these cohesive forces. Soils composed of mainly coarser material (sands and silts i.e. frictional soils) have no true cohesion and limited apparent cohesion; as suction forces between the grains are weak and inter-particle electro-static forces do not exist. However, the aggregation of particles can still occur due to the existence of micro-filament root and fungal fibers. Inter-particle bonds are established as the micro-filaments link individual soil particle together. As well, some of the fungal organisms produce glomulin (a protein) which can act as a binder between soil particles (Brady and Weil 1999). How much apparent cohesion results from this microscopic reinforcement is unclear.

Figure 1. Scanning electron microscope images of fungal filaments and soil particles. From Brady and Weil, 1999.

Figure 1: Scanning electron microscope images of fungal filaments and soil particles. From Brady and Weil, 1999.



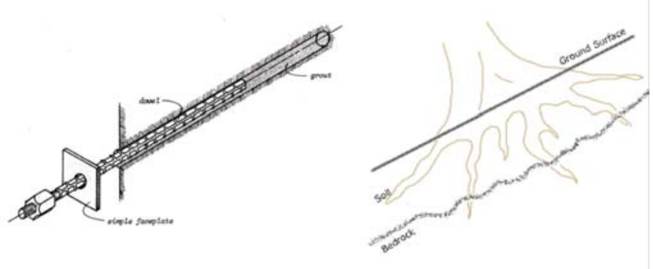
ii) Vertical Anchoring

Several researchers have noted tree roots exposed in the failure scarps of landslides. These roots are either broken or appear intact. Each occurrence reflects a different result of the interaction of the root / soil boundary. Broken roots indicate that the frictional strength of the root / soil boundary was greater than the tensile strength of the root. Intact roots indicate the inverse. Both situations show the roots acting as anchors in tension. This behavior is analogous to passive rock bolts in a rock slope (figure 2). These bolts help to support the dead weight of the slope (Hoek and Brown 1980), but do not increase the normal stresses on the slope; therefore, no additional frictional resistance is mobilized.

The peak strength of these roots is mobilized once movement of the soil mass has begun (Norris and Greenwood, 2000). If the driving forces of the slope are less than both the tensile strength of the roots and the frictional resistance of the root / soil boundary, the landside may be stopped. It is clear that these roots do not add "cohesion" to the soil (Greenway, 1987).

Figure 2. Rock bolt held into the rock by the bolt/frictional interface analogous to strong roots/soil frictional interface. Roots may also be anchored into bedrock or parent material below organic soil.

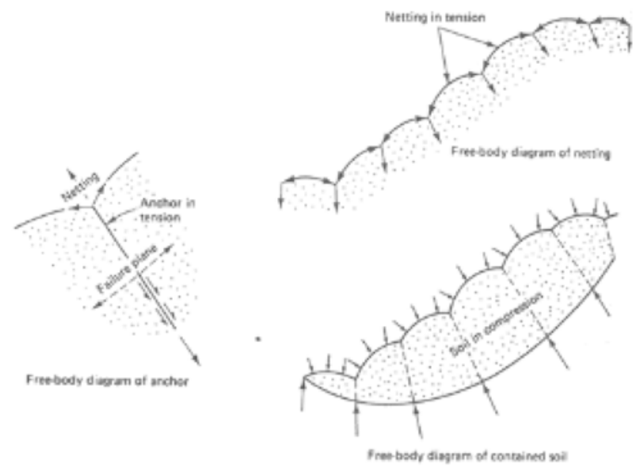
Figure 2: Rock bolt held into the rock by the bolt / rock frictional interface analogous to strong roots / soil frictional interface. Roots may also be anchored into bedrock or parent material below organic soil.



iii) Lateral Support

Lateral support of soil covers in slopes has been observed in several studies (Wu and Watson, 1998, Preston and Crozier, 1998). A network of roots from numerous plants results in thin, highly reinforced surface zone. This dense root mat can "hold" soil in place if it begins to move. Preston and Crozier (1998) observed root mats that were capable of stopping incipient earth slides. Minor displacements were observed beneath an intact root mat composed of mainly pasture vegetation. Earth slides occurred unimpeded in areas where the root mat had been broken. When combined with the anchor roots of plants that are incorporated into the root mat, this behaviour is analogous to an anchored geo-textile netting (figure 3). The type of reinforcement provided by the root mat is not representative of cohesion. An additional form of lateral support is provided by the vertical anchor roots. These anchor roots establish "root columns" in the soil which provide buttressing to the soil upslope.

Figure 3: Geo-textile anchored netting as an analogue for root mat reinforcement. From Koerner, 1990



Factoring in Root "Cohesion"

The above overview has shown that only one of the three main mechanical stabilization mechanisms that roots are capable of would affect the soil cohesion. Most practitioners recognize that "root cohesion" is a term that describes less the mechanical processes at work and more the way this reinforcement is determined from simple slope stability equations. When root reinforcement is factored into simple slope stability models (i.e. the infinite slope equation, with Coulomb failure criterion) to produce factors of safety (FS) estimates a cohesion term is regularly used. In addition to the semantics issue, two practical issues result: how is the root reinforcement estimate made and how is pore water pressure accounted for? Estimates of root reinforcement have initially been based on relations of the size of the root, the tensile strength of the root and the type of root structure (Wu et al. 1999). Other methods like in-situ shear box testing (Wu and Watson, 1998 and Norris and Greenwood, 2000) infer the amount of root reinforcement through field experiments. Calculations based on root characteristics can only be produced once a failure has occurred and the roots are exposed. In – situ shear box testing results in a location must be extrapolated to nearby slopes. However variations in soil quality and vegetation growth / type may confine in-situ testing to small areas. Current equations for determining root reinforcement require assumptions regarding anchoring and root orientation. None of this data is readily available to the field practitioner.

In an effective stress analysis, pore water pressures reduce the amount of normal stress available to mobilize frictional resistance of the soil material. By including root reinforcement as a cohesion term, pore water pressure effects on the root / soil boundary cannot be considered (strength at this boundary is derived from friction). This may lead to an overestimation of the root reinforcement when a back analysis is completed for a failure. When these calculated root reinforcement values are used in the future, over estimates of the factor of safety for a slope may be produced.

An alternate methodology (and another rock mechanics analogue) may be to follow the “asperity” or “joint roughness” model. In this case shear resistance on a rough planar surface is increased by the presence of the roughness elements. The effect of these elements is to increase the friction angle of the planar surface. The plausibility of this method of incorporating root reinforcement has not been examined by the author and is purely speculative (equation 1). Data from shear box tests could be used to follow this line of reasoning.

Equation 1: Shear resistance (Sr) for a soil in effective stress conditions, where root reinforcement (R) is incorporated as an addition to the friction angle of the soil.

$$Sr = c + (\sigma - u) \tan(\phi + R)$$

Summary

The removal of tree cover and resulting loss of living roots has been shown to have a negative impact on the stability of forested slopes. However, a loss of root “cohesion” or more properly root “reinforcement” is likely only one of the causes. Increases in soil water in the slopes due to drainage diversions from the vegetation harvesting, no evapotranspiration by trees and increased infiltration in exposed soil must account for some of the added instability. How the loss of root reinforcement compares to these other factors in terms of magnitude is still unknown.

By using the term “cohesion” when discussing root reinforcement, confusion about the mechanisms involved are common. As well, continued use of the cohesion term in the Coulomb failure criterion may lead to overestimates of root strength. Other methods for incorporating root reinforcement values should be explored.

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Application of Artificial Neural Networks for Terrain Stability Mapping

Mihai Pavel, Ph.D. Candidate, UBC

Introduction / Background

The introduction of the Forest Practices Code (FPC) in British Columbia has increased the need for terrain stability mapping and associated ground checks. The purpose of this mapping is: (1) to identify the timber harvesting land base, and 2) to minimize the occurrence of landslides and their impacts. Terrain stability assessments are an important part of forest development plans as they aim to delineate areas of potential instability, and identify zones that require detailed ground checks.

The method currently in use in BC is the genetic method, performed according to the Mapping and Assessing Terrain Stability (MATS) Guidebook of FPC (Anon. 1999a), which is based mainly on the Terrain Classification System of BC (Howes and Kenk 1997). This is a subjective method, in which the expertise and experience of the mapper play a very important role. More recently, objective methods based on computer modeling and statistics have also been investigated (Pack et al. 1998; Rollerson et al. 2002).

Rationale

None of the existing methods seem to yield consistently good results, and be generally accepted for practical applications. It is common knowledge that when mapping is performed based on subjective methods, the results vary significantly from one mapper to another; furthermore, if the same specialist maps the same area at different times, results are very likely to be different. Objective methods are affected by the complex topographic, hydrologic and geomorphic structure of hillslopes and existence of hidden features, which makes prediction unreliable. Recent studies (Jaakkola 1998) proved that even the most current tools developed for landslide risk assessment, yield predictions that are inconsistent with field observations.

The current situation inspired the idea of using Artificial Neural Networks (ANN) to overcome the known shortcomings of existing models. In this study, topographic and geomorphic data stored in a Geographic Information System (GIS), were analyzed with ANN to assess terrain stability.

Objectives

The objective of this project was to develop a model for terrain stability assessment, to be used by the Forest Industry in BC. This model is intended to be a decision support tool which will reduce expensive ground checks to the most vulnerable areas and provide guidance to terrain specialists for decisions on harvest block and layout.

Methods

Study sites

The method developed in this study was tested on two study areas: (1) Seymour Watershed, in the Greater Vancouver Regional District (GVRD). Data for this region was collected as part of a multi-year project that was managed by Acres International Limited (1999b); and (2) A site on Northern Vancouver Island, offered by the industrial partner involved in this study. Each site had an area of about 50 km^2. For both sites terrain stability mapping was performed by (well-known) consultants from BC.

Model development

Model development was based on application of ANN. An ANN is an information-processing system that has certain performance characteristics in common with biological neural networks. ANNs have been developed as generalizations of mathematical models of human cognition and neural biology, and they can be applied to a wide variety of problems. From the many types of ANN available, this study used the Self-Organizing Maps, developed by Kohonen (2001). Data storage and manipulation was performed in ArcView GIS (ESRI 1998).

Terrain stability analysis was investigated in relation to various types of data that are available to terrain specialists. Terrain attributes related to (terrain) stability were investigated and the combination of attributes that produces the best prediction was identified.

The following types of data were included in the analysis:

1. Geomorphic attributes: collected according to the MATS Guidebook (Anon. 1999a), and the Terrain Classification System of BC (Howes and Kenk 1997):
   i) Surficial and subsurficial material type.
      - Texture of (surficial and subsurficial) materials.
      - Surficial expression of (surficial and subsurficial) materials.
   ii) Geomorphic processes identified in the area.
   iii) Slope class of terrain polygons.

2. Digital representation of topography: Terrain Resource Inventory Mapping (TRIM) data were used in this study. A Digital Elevation Model (DEM) was created for each study site, and the following topographic parameters (relevant for stability assessment) were calculated:
   - Elevation.
   - Slope.
   - Aspect.
   - Plan curvature.
   - Profile curvature
   - Interaction of curvatures (analyzed as a distinct parameter).
   - Specific catchment area: this represents the upslope catchment area divided by unit contour width. Calculation of this parameter was performed based on Pack et al. (1998).

The model aimed at identifying attributes most relevant to terrain stability mapping. The objective was to perform accurate terrain stability mapping based on a reduced set of geomorphic and topographic attributes.

Model testing

The model was tested in the two watersheds included in the study. Each watershed was divided in two parts: 2/3 of the data was used for developing the model, and 1/3 of the data was used for testing it. Results were compared with existing mappings performed by terrain stability specialists.

Results and Comments

The attributes that proved to be important in analysis were: geomorphic processes, slope, elevation and aspect. Predictions based on these attributes delineated unstable and potentially unstable terrain in the two sites with an accuracy of 91% and 87%, respectively.

These results show that accurate mappings can be obtained based on a very simplified terrain classification which includes only geomorphic processes and a subset of topographic attributes. With data and technology currently available in BC the model is easy to apply. Identification of areas affected by adverse geomorphic processes can be quickly and accurately done on air photos and then transferred in digital format. Digital photogrammetry can significantly increase the speed of this process. Topographic attributes can be easily obtained at low costs. The method presented can be applied with good results in most common situations. For areas characterized by a very complex stratigraphy, it is recommended that experienced terrain mappers be involved.

Discussion

It is common knowledge that terrain stability models need to also have temporal resolution, i.e. the ability to predict terrain instability that may develop over long periods of time. Along with landslide initiation, there is also a need for assessment of travel distance of debris and a corresponding evaluation of risk to downslope resources (Fannin and Wise 2001). The method used in this model makes it feasible to address both these problems as a next step in its development (Pavel 2003). Thus, this model could be applied for independent risk analyses, or implemented in a forest planning software (e.g. fps – ATLAS; Nelson 1999), to assess changes in terrain stability in connection with forest development and impacts on timber supply.

It is believed that the new model will allow the production of a hazard classification map over a large area in a relatively short time. It has the potential to increase both the speed and objectivity of terrain stability mapping. It will provide useful information and will focus expensive ground checks on the most vulnerable areas. The model will also be a tool that can provide information necessary for addressing the following issues: (1) loss of site productivity; (2) loss of operational revenue; (3) minimizing adverse impacts on aquatic resources; (4) minimizing environmental liability in forest operations.

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BALLOTS MAILED FOR DEGIFS EXECUTIVE ELECTION

- IT'S TIME TO VOTE -

All DEGIFS Members who are registered APEGBC members should have received DEGIFS Executive ballots in the mail. You are reminded and encouraged to vote and submit your ballots such that they are received by noon, October 8th. There is an excellent slate of candidates. Please review their statements and vote for those you think are the best choice for the DEGIFS Executive.

Your candidates are:

Ron Arksey, P.Geo., Contour Geoscience Ltd., Comox
Heather Blyth, P.Geo., Blyth Consulting Ltd., Victoria
Brian Chow, P.Eng., BC Ministry of Forests, Victoria
Tim Dunne, RPF, P.Eng., Forsite Management Consultants Ltd., Salmon Arm
Carl Erickson, P.Eng., BC Ministry of Forests, Prince George
Deepali Filatow, P.Geo., BC Ministry of Sustainable Resource Management, Kelowna
Neil Froc, P.Eng., Mountain Geoscience Inc., Lindell Beach
Mark Goldbach, P.Eng., Golder Associates Ltd., Chilliwack
James Hogarth, P.Eng., Piteau Associates, Squamish
Don Williams, P.Eng., AllNorth Consultants Ltd. Prince George

PLEASE VOTE!!

Who we are!

Editorial Board

Do Not Forget!!!

ASPECT SUBMISSIONS:

LAST DATE FOR SUBMISSIONS TO ASPECT	NEWSLETTER RELEASE DATE
MAR. 8, 2003	MAR. 29, 2003
JULY 5, 2003	JULY 26, 2003
SEPT. 6, 2003	SEPT. 27, 2003
NOV. 22, 2003	DEC. 13, 2003

Electronic submissions in **Word format (only)** should be made to Bruce Thomson by the date listed above (no exceptions) (bruce.thomson@gems3.gov.bc.ca).

Refer to *Guidelines for Submission* on the website http://www.degifs.com/guidelines.doc for submission requirements.

DEGIFS Executive

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