34th International Geological Congress
Brisbane, Australia 2012

Criticisms of the Landslide Inventories Following Road Use Change in Mountainous Highways:

Relocation, dimensions analysis & hazard zonation

SHAHRAM NASIRI

M.R. SHIRZAD, A. UROMEIHY, A. REZAEI. & H. PEDRAM

Geological Survey of Iran

National Geoscience Database of Iran

www.ngdir.ir

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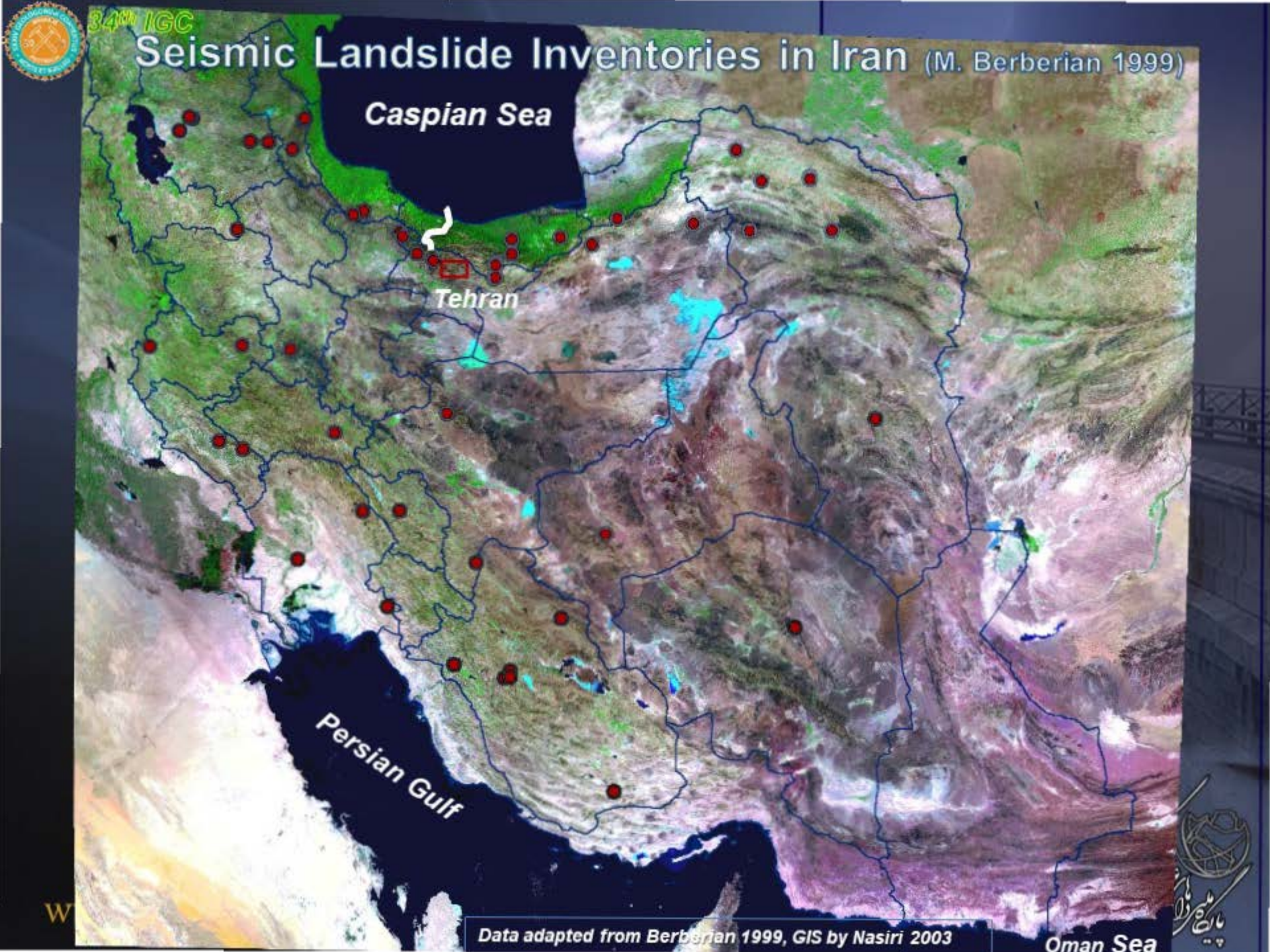
Central ALBORZ Mountain Chalous Highway

Are Pre-Landslide Inventories Trustworthy?

Is This Unreliability Inevitable?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Seismic Landslide Inventories in Iran (M. Berberian 1999)
Caspian Sea
Tehran
Persian Gulf
Oman Sea
Data adapted from Berberian 1999, GIS by Nasiri 2003

Image adapted from Hormann 2007, Data added by Nasiri 2012

Mountainous Highways Physiography In the Alborz Range

View:	Mount Damavand
Location:	Lon 53.648° Lat 35.55°
Altitude:	59 km
Direction:	290°
Camera Angle:	43°
User Rating:	2.5

Image adapted from Hormann 2007, Data added by Nasiri 2012

Foundation History & Traffic Bar

View:	Northern Iran
Location:	Lon 50.515° Lat 34.458°
Altitude:	59 km
Direction:	30°
Camera Angle:	45°
User Rating:	2.7

N

Caspian Sea

%35

%40

%25

Traffic Bar Proportion
(No/Hour)

1933

1963

1930

Firoozkuh

201?

ALBORZ Mountain

Tehran

Haraz

1961

Tehran Shomal

Tehran
12 millions people

4 billions$
Developing to
4-Band Highway

Chalous

Central Iranian Deserts

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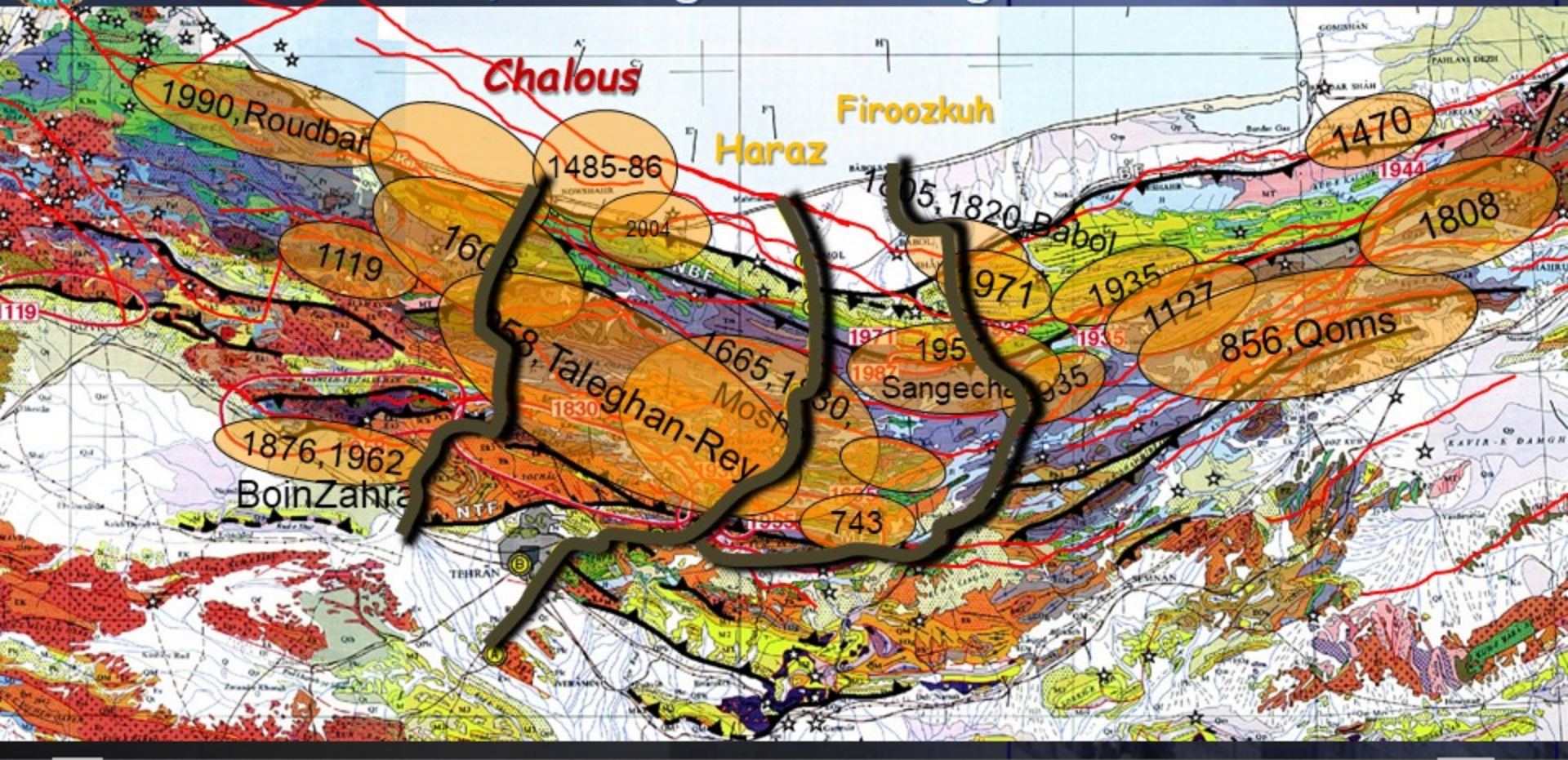
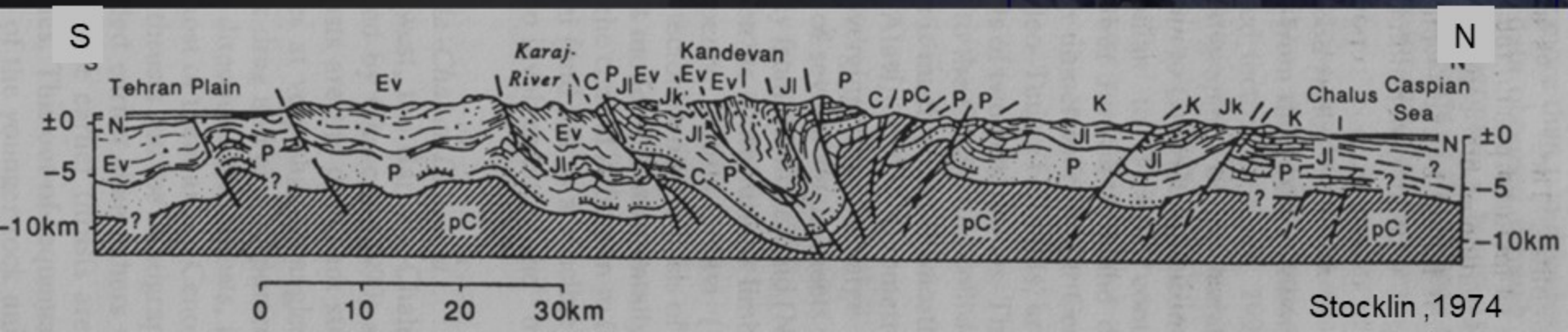
Central Alborz, Geological Setting & Macroseismic Area





Stocklin ,1974

Background Studies (Projects)

Important Engineering Projects of the Study Area

Foundation timeline

201 ?

2012

Under construction

SIAH-BISHEH Pumped Storage Dam

Tehran-Shomal Freeway

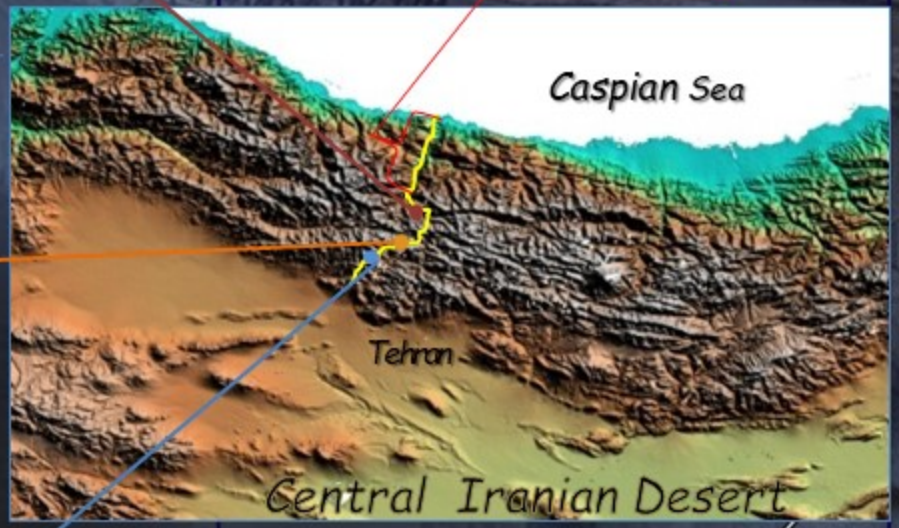
2002

Constructed & Improvment

KANDOVAN Tunnel

AMIR-KABIR Dam

1963



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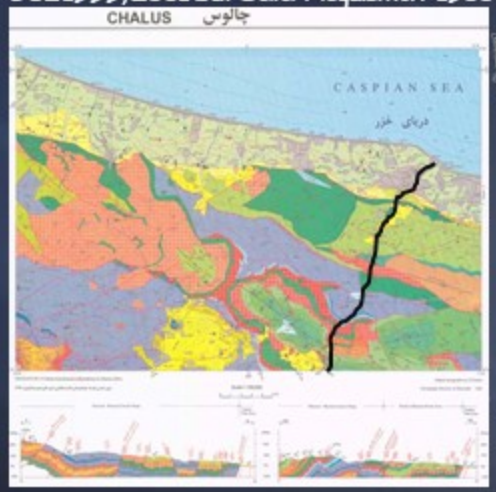
Background Studies (Data)

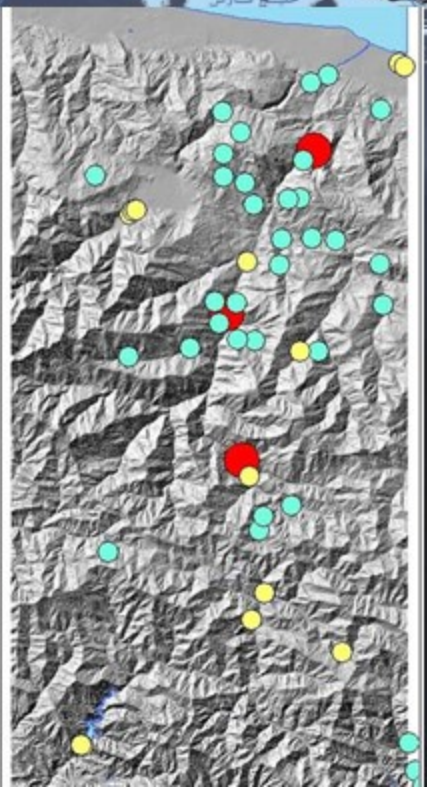
100 K Geologic map

GSI 1999, 2001 but Data Acquisition 1965



Landslide Database of Iran

(MAJI 2003) but Data Acquisition 1990



No of LS in pre-inventories

3 > 100 acre

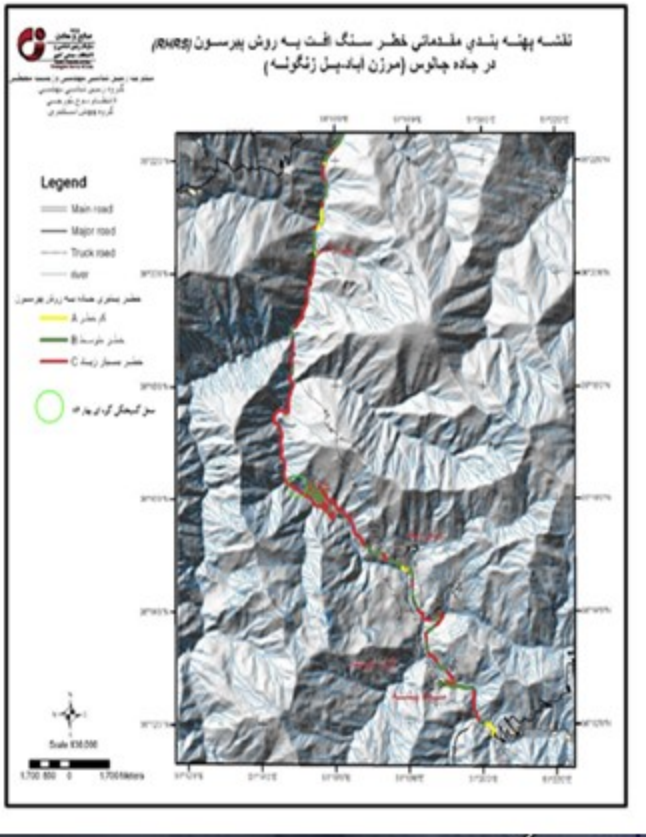
33 > Medium

12 > Local

Total 47

Rock fall Hazard

(GSI 2007) base on Hazard Rating System (RHRS) developed by Pierson et al. (1990)



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Recent Events (Landslide Records)

Baladeh Earthquake

75 Records, 17 killed
28 May 2004 (Ms = 6.3)

Rock Falls During Rain Fall

8 Records Middle part

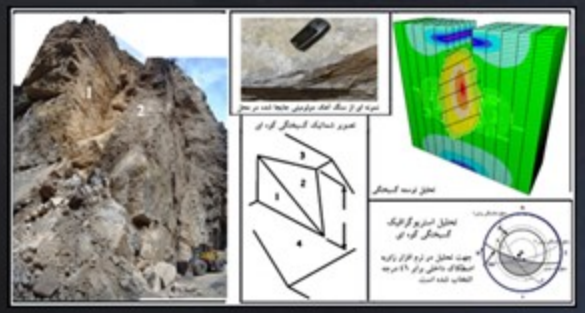
Slope Instabilities in Foundation of Eng. Projects

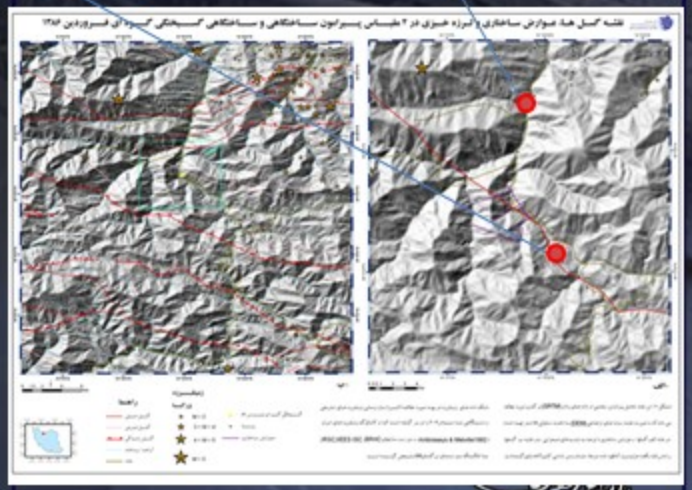
12 Records, mostly Slump & earth slide

Rural Slope Instability

23 Records, Anthropogenic activities & Building Excavations

Macroseismic Area of Baladeh Eq.





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Recent Events (Rural Development)

YEAR	1930	1980	2000	2012	YEAR
Population Growth Number of Population	~2000	18125	80483 (8.8 times)	160972	
Average Growth rate (PGR)	.08	?	1.5	1.2	

Rural Roads Development
Length km

1970 ~12 km

6.9 times

83.5 km

Buildings & Resorts Development
Area (Square km)

1975 10.2 km²

5.6times

57 km²

SRTM 10 m Processing

نقشه ی شیب در محدوده مورد مطالعه، گستره ی ساختگاه خطی جاده تهران –چالوس و پیرامون

شرح:
این نقشه حاصل پردازش بخشی از داده های ماهواره ای رادار
برداشت سال ۲۰۰۰ در پهنه البرز مرکزی است که همپوشانی
نقشه سایه های ارتفاعی با دقت سطوحی سی مترتهیه شده است

نگیاره ماهواره ای سر پایه نقشه های رقومی توپوگرافی ۱:۵۰۰۰۰
جاماسایی و تصحیح شده است

راهنما

شهر/روستا

دریا/دریاچه

درجه شیب

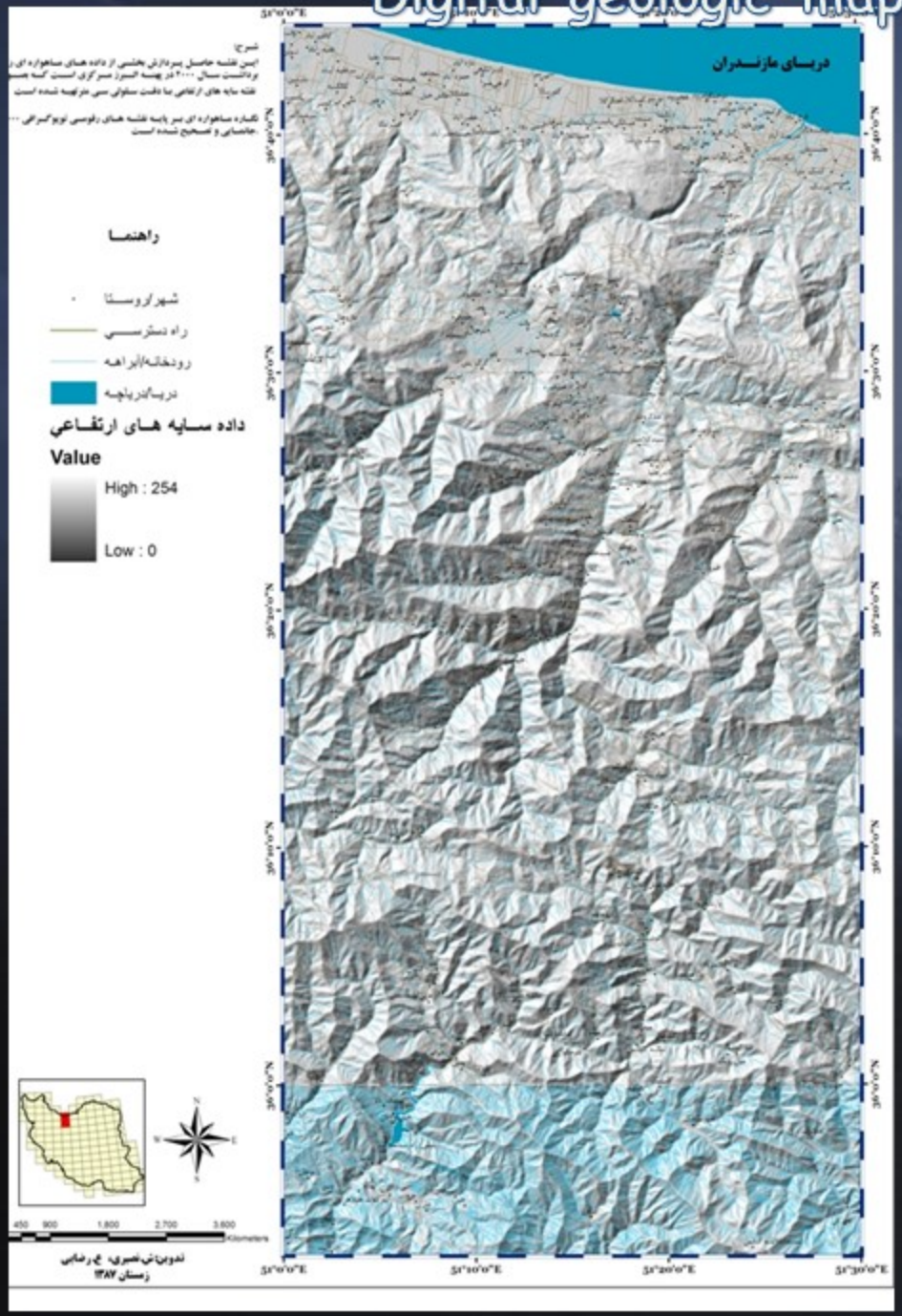
- 0 < S < 5
- 5 < S < 10
- 10 < S < 15
- 15 < S < 20
- 20 < S < 25
- 25 < S < 30
- 30 < S < 35
- 35 < S < 40
- 40 < S <

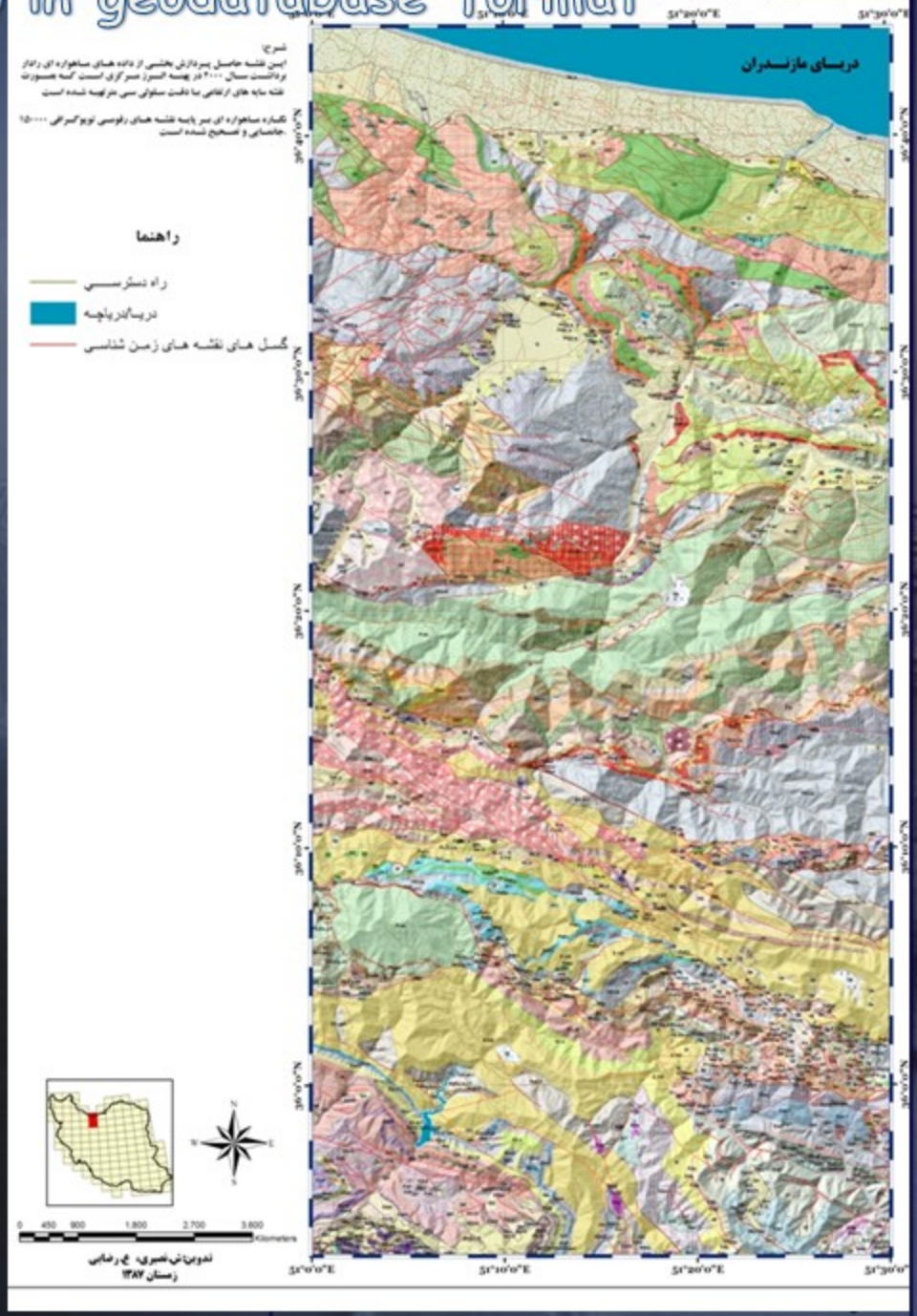
دریای مازندران

450 900 1,800 2,700 3,600 Kilometers

تدوین: ش. نصیری، ح. رضایی
زمستان ۱۳۸۷

Digital geologic map in geodatabase format





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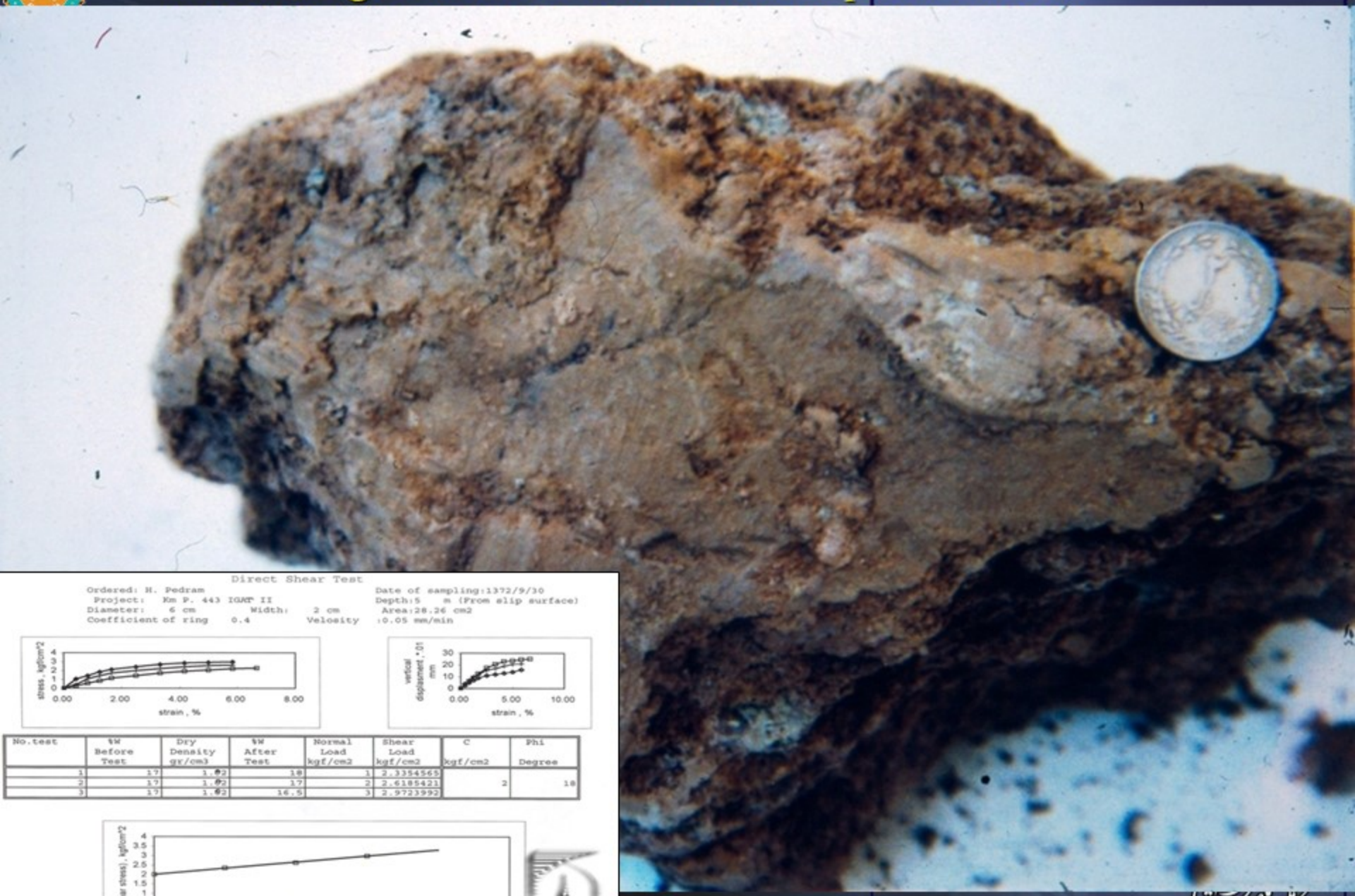
Geotechnical Database

Symbol	Formation	Geologic Description	Uni axial strength (MPa)	GSI) (value	mi) (value	Cohesion (Kg/cm2)	Friction angle
Cbj	سازند جیرود	آهک تیره با میان لایه های مارن رسی	55	12	10	0.27	36
Cbt	سازند باروت	سیلتستون و شیل با میان لایه های دولومیت چرتی	45	10	7	0.25	33
Ccj	سازند جیرود	دولومیت توده ای خاکستری روشن	75	32	14	0.30	37
Cdbt	سازند باروت	دولومیت توده ای تیره با میان لایه های شیل سبز	75	32	14	0.30	37
Cdj	سازند جیرود	آهک االیتی اینتراکلاست دار تیره	55	12	12	0.27	36
Cl	سازند لالون	ماسه سنگ آرکوزی قرمز	120	57	21	0.37	40
Cm	سازند مبارک	آهک، دولومیت، شیل و ماسه سنگ	52	11	12	0.27	34
Cq	سازند میلا	کوارتزیت، ماسه سنگ سیلیسی	300	90	22	1	46
Cql	کوارتزیت فوقانی	ماسه سنگ آرکوزی سفید	300	90	22	1	46
Cz	سازند زاگون	سیلتستون، شیل آهکی با میان لایه های دولومیت چرت دار	45	10	7	0.25	33
Daj	سازند جیرود	ماسه سنگ، شیل، آهک و مارن	90	43	15	0.32	40
D-Cg	سازند جیرود	ماسه سنگ شیل و آهک	90	43	14	0.32	40
Dvj	سازند جیرود	گدازه های آندزیتی- بازالتی	170	73	25	0.40	43
Ea1	سازند کرج (شیل پایین)	جریان های گدازه ی آندزیتی و داسیتی به همراه برش توفی	200	78	23	0.43	40
Eab1	سازند کرج (شیل پایین)	برش گدازه ی بازالتی و آندزیتی	210	85	25	0.43	41
Eak	سازند کرج (توف بالایی)	بازالت - آندزیت، توف	110	54	19	0.35	41
Bb1	سازند کرج (شیل پایین)	برش گدازه ی بازالتی و آندزیتی	210	85	25	0.43	41

The same geo unit from Landslide Rupture Surface



Direct Shear Test

Ordered: H. Pedram
Project: Km P. 443 IGAT II
Diameter: 6 cm Width: 2 cm
Coefficient of ring 0.4 Velocity

Date of sampling:1372/9/30
Depth:5 m (From slip surface)
Area:28.26 cm2
:0.05 mm/min

No.test	%W Before Test	Dry Density gr/cm3	%W After Test	Normal Load kgf/cm2	Shear Load kgf/cm2	C kgf/cm2	Phi Degree
1	17	1.62	18	1	2.3354565		
2	17	1.62	17	2	2.6185421	2	18
3	17	1.62	16.5	3	2.9723992		

Landslide-area-Chalous5, 08/03/2012, Page 1-1

FID	Possible	Type	Depth	Area
0	Glacial Deposits			1494880.70808
1	Glacial Deposits			1172544.67714
2	Glacial Deposits			1330489.33306
3	Glacial Deposits			3170473.45774
4	well-defined		intermediate	99161.534431
5	well-defined		intermediate	1351766.31119
6	well-defined		intermediate	341723.169718
7	well-defined		intermediate	490078.742532
8	well-defined		intermediate	239079.763584
9	well-defined		intermediate	1585970.82231
10	infered		shallow	148796.924894
11	well-defined			405409.484914
12	well-defined			558192.413429
13	infered			221004.564571
14	infered			387917.268945
15	well-defined			70297.238696
16	infered			74028.069032
17	well-defined			359335.946407
18	well-defined			102198.943022
19	Glacial Deposits			599832.336598
20	well-defined			586028.756237
21	well-defined		intermediate	886575.587928
22	Glacial Deposits			355203.297837
23	well-defined	wedge failure	shallow	214896.072223
24	Glacial Deposits			498003.408364
25	infered			37783.343182
26	infered	Flow		220167.102583
27	well-defined			506521.087322
28	infered			161329.891327
29	infered			265261.131049
30	Glacial Deposits			782306.602881
31	infered			377454.50609
32	well-defined		shallow	336798.098952
33	infered			333128.262247
34	infered			2263108.81462
35	Glacial Deposits			826356.011404
36	well-defined		shallow	94895.948558
37	probably displaced		intermediate	176254.558722
38	well-defined		shallow	51737.145046
39	well-defined		shallow	83080.963648
40	infered		intermediate	400637.52144
41	well-defined		intermediate	148325.252504
42	infered		intermediate	102942.168719
43	well-defined		intermediate	51080.136835
44	well-defined		superficial	15502.262574
45	infered		intermediate	96848.64643
46	well-defined		deep	747016.263151
47	well-defined		shallow	60509.685403
48	well-defined		deep	594478.154846
49	infered	wedge failure	shallow	136583.63523
50	well-defined		shallow	66479.365991
51	well-defined		intermediate	95041.709692
52	well-defined		intermediate	107908.324411
53	well-defined		deep	694830.816887
54	well-defined		deep	401649.118799
55	infered		intermediate	709272.599146
56	infered		superficial	95803.851996
57	infered		shallow	1491998.70699
58	infered		deep	619886.395728
59	infered	wedge failure	superficial	65549.248597
60	well-defined	wedge failure	superficial	25180.519188
61	infered		intermediate	237951.523534
62	infered	wedge failure	superficial	85059.016753
63	well-defined	wedge failure	superficial	106161.561627
64	infered	Displaced		1649649.70648
65	well-defined	wedge failure	superficial	119637.401914
66	well-defined	wedge failure	shallow	371206.648086
67	infered			211734.021738
68	infered	mud flow	superficial	33349.900765
69	well-defined	scree		427193.30889
70	infered	eroded and compound	shallow	444182.358947

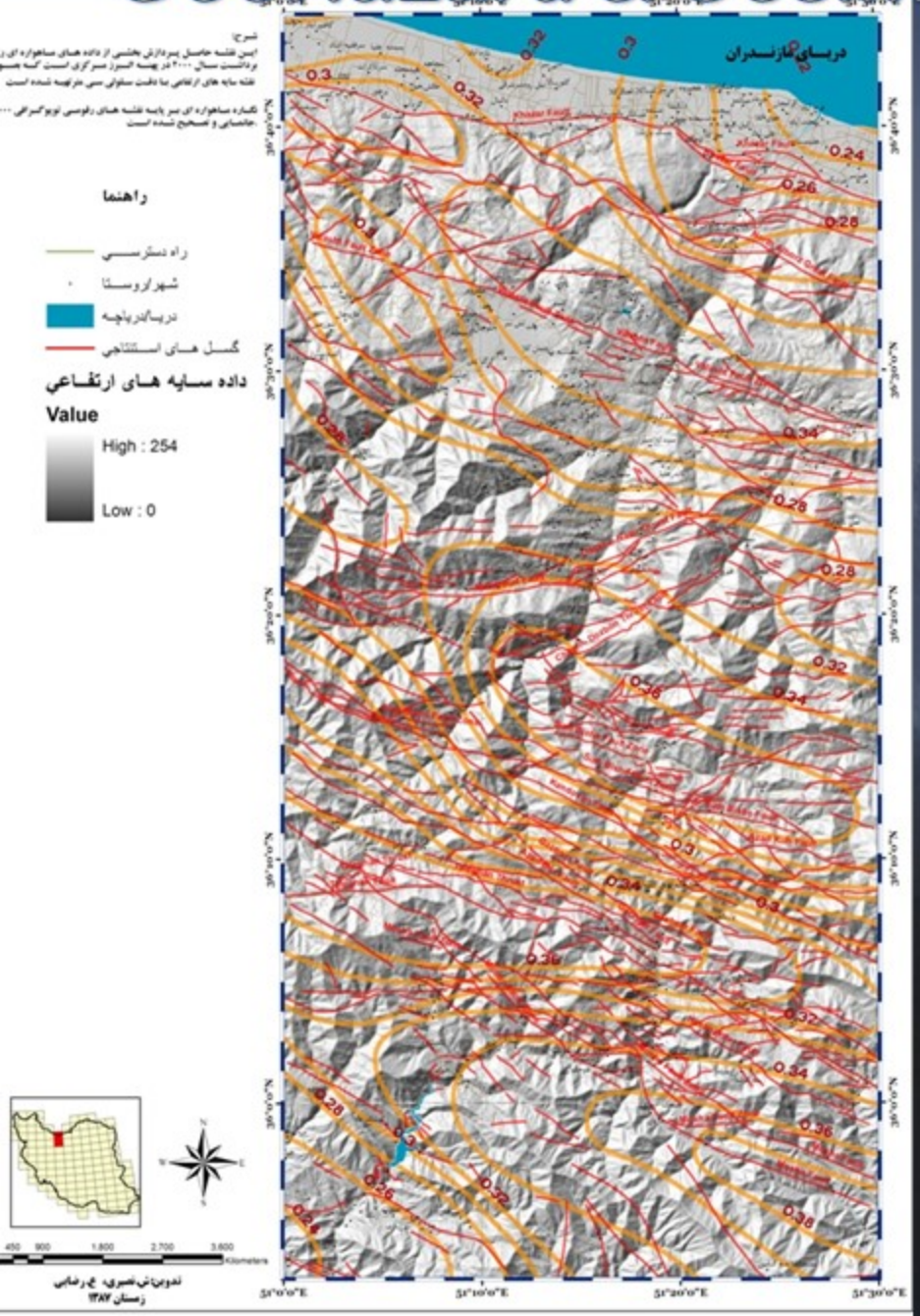
Landslide-area-Chalous5, 08/03/2012, Page

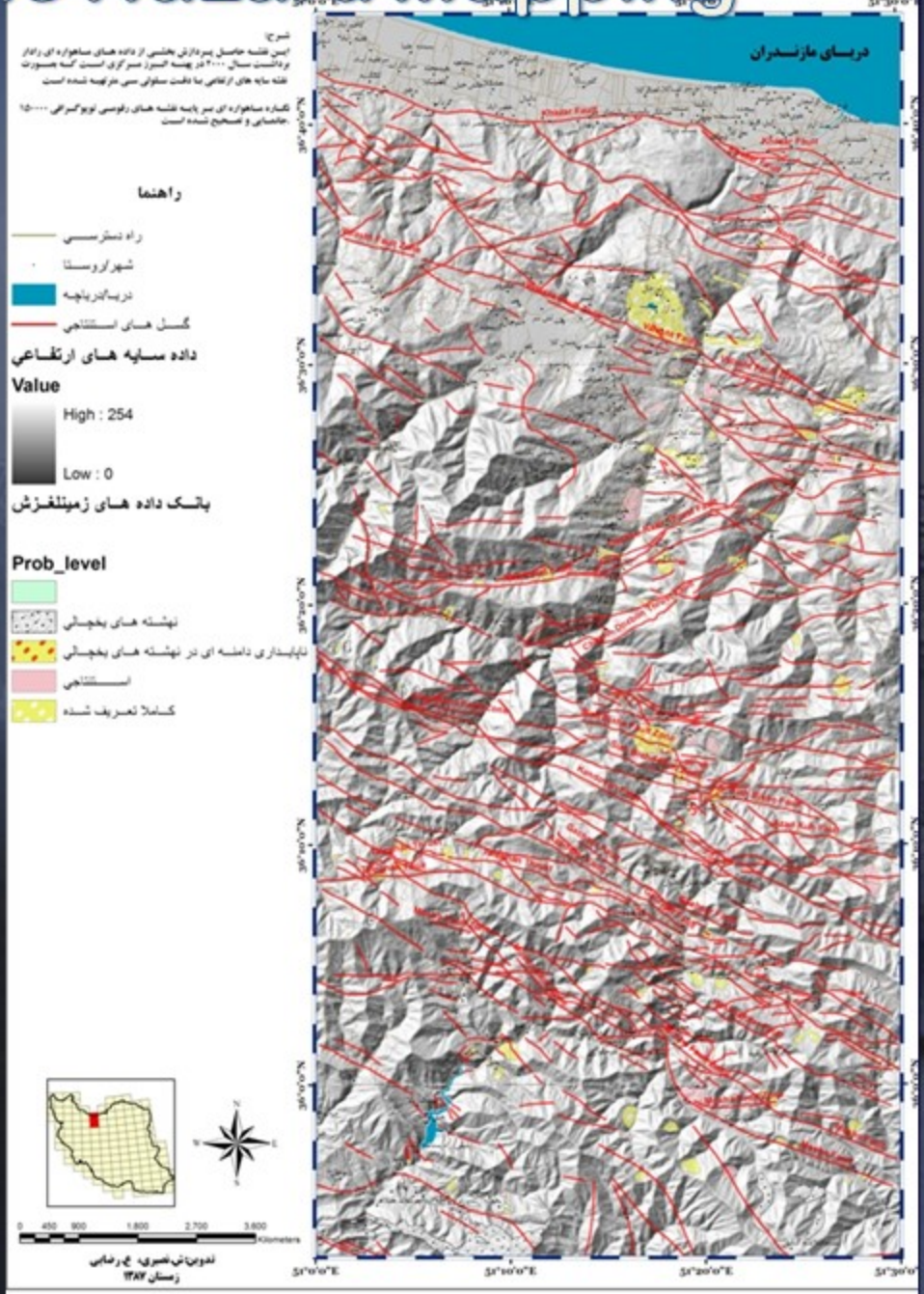
FID	Possible	Type	Depth	Area
71	well-defined		shallow	1333227.61956
72	well-defined		superficial	1782136.05424
73	well-defined		superficial	1006424.24064
74	well-defined	mud flow		747717.253891
75	well-defined	wedge failure	superficial	317592.897661
76	infered	wedge failure	shallow	3830915.42756
77	infered			3393797.49556
78	well-defined			110223.709077
79	infered	mud flow		464088.044769
80	infered			148163.058703
81	well-defined			76925.229775
82	well-defined			439223.123193
83	well-defined	earth flow		2380102.65133
84	well-defined		intermediate	689877.872741
85	well-defined		intermediate	304863.269505
86	well-defined		shallow	915505.039597
87	well-defined			37491.789482
88	infered		shallow	225961.649345
89	well-defined		shallow	944705.386573
90	well-defined		intermediate	3998624.29467
91	infered		shallow	1263865.10217
92	well-defined		shallow	559548.310448
93	infered		shallow	340570.230362
94	well-defined		intermediate	162383.329433
95	well-defined	earth flow		370494.378062
96	well-defined			170541.157677
97	well-defined	earth flow	shallow	2478394.14087
98	well-defined		intermediate	295834.951445
99	well-defined		superficial	99681.716768
100	well-defined		shallow	109194.812464
101	well-defined		deep	547333.818171
102	well-defined		intermediate	962787.253505
103	well-defined	earth flow	deep	493971.530563
104	well-defined		shallow	140082.994503
105	well-defined		shallow	407407.106696
106	well-defined		deep	15527734.1642
107	well-defined	earth flow	superficial	687975.351208
108	well-defined	earth slide	intermediate	203231.098592
109	well-defined	mud flow	superficial	40359.637396
110	infered		shallow	264709.124698
111	infered			315503.265297
112	probably displaced			767550.634814
113	probably displaced			103821.967136
114	probably displaced			406016.463491
115	infered		shallow	148567.392985
116	well-defined		intermediate	329093.320181
117	infered	Scree		96135.984515
118	infered		intermediate	231331.262326
119	infered	wedge failure	superficial	769987.66991
120	infered			45995.489399
121	infered	mud flow	superficial	104058.606324
122	intensive erosion			2726031.58989
123	well-defined			14025.79375
124	infered-undercutting			273196.639169
125	well-defined		intermediate	30256.280807
126	infered		shallow	24028.231336
127	well-defined		very deep	3232535.99406
128	well-defined		very deep	1039357.94129
129	well-defined		intermediate	73881.730036
130	infered		shallow	341001.977237
131	well-defined		shallow	338134.115496
132	infered		shallow	233143.685773
133	infered		intermediate	173570.951245
134	infered		shallow	2431513.94
135	infered	mud flow	superficial	116893.951509
136	infered		intermediate	156815.460453
137	infered		intermediate	693450.185509
138	infered		shallow	113278.689242
139	well-defined		intermediate	406045.849183
140	well-defined		shallow	354160.657221
141	well-defined		shallow	30572.821147

FID	Possible	Type	Depth	Area
142	well-defined		shallow	110984.189352
143	well-defined		superficial	414893.33886
144	well-defined		shallow	863988.234732
145	well-defined		shallow	267268.047827
146	well-defined		shallow	127634.536139
147	well-defined		intermediate	706370.560295
148	well-defined		shallow	489023.452695
149	well-defined		shallow	231625.408444
150	well-defined		shallow	142570.281526
151	infered		superficial	38658.953713
152	well-defined		shallow	210551.59018
153	infered		intermediate	124407.337915
154	well-defined		shallow	57134.66412
155	well-defined		shallow	13599.37796
156	well-defined		superficial	0
157	infered		shallow	0
158	infered	eroded and compound	shallow	0
159	infered		superficial	0
160	Glacial Deposits			0
161	well-defined		superficial	0
162	well-defined		shallow	0
163	infered		shallow	0
164	well-defined	scree	superficial	0
165	well-defined	scree	superficial	0
166	well-defined	scree	superficial	0
167	well-defined		shallow	0
168	well-defined		intermediate	0
169	well-defined	scree	superficial	0
170	infered		shallow	0
171	infered		shallow	0
172	well-defined		shallow	0
173	well-defined		intermediate	142619.671022
174	infered		superficial	142619.671022
175	Glacial Deposits			0
176	Glacial Deposits			0
177	Glacial Deposits			0
178	infered		shallow	0
179	well-defined		shallow	0
180	well-defined		shallow	0
181	Glacial Deposits			0
182	Glacial Deposits			0
183	well-defined		shallow	0
184	Glacial Deposits			1534792
185	Glacial Deposits			19289050
186	Glacial Deposits			0
187	Glacial Deposits			0
188	Glacial Deposits			0
189	Glacial Deposits			0
190	Glacial Deposits			0
191	Glacial Deposits			0

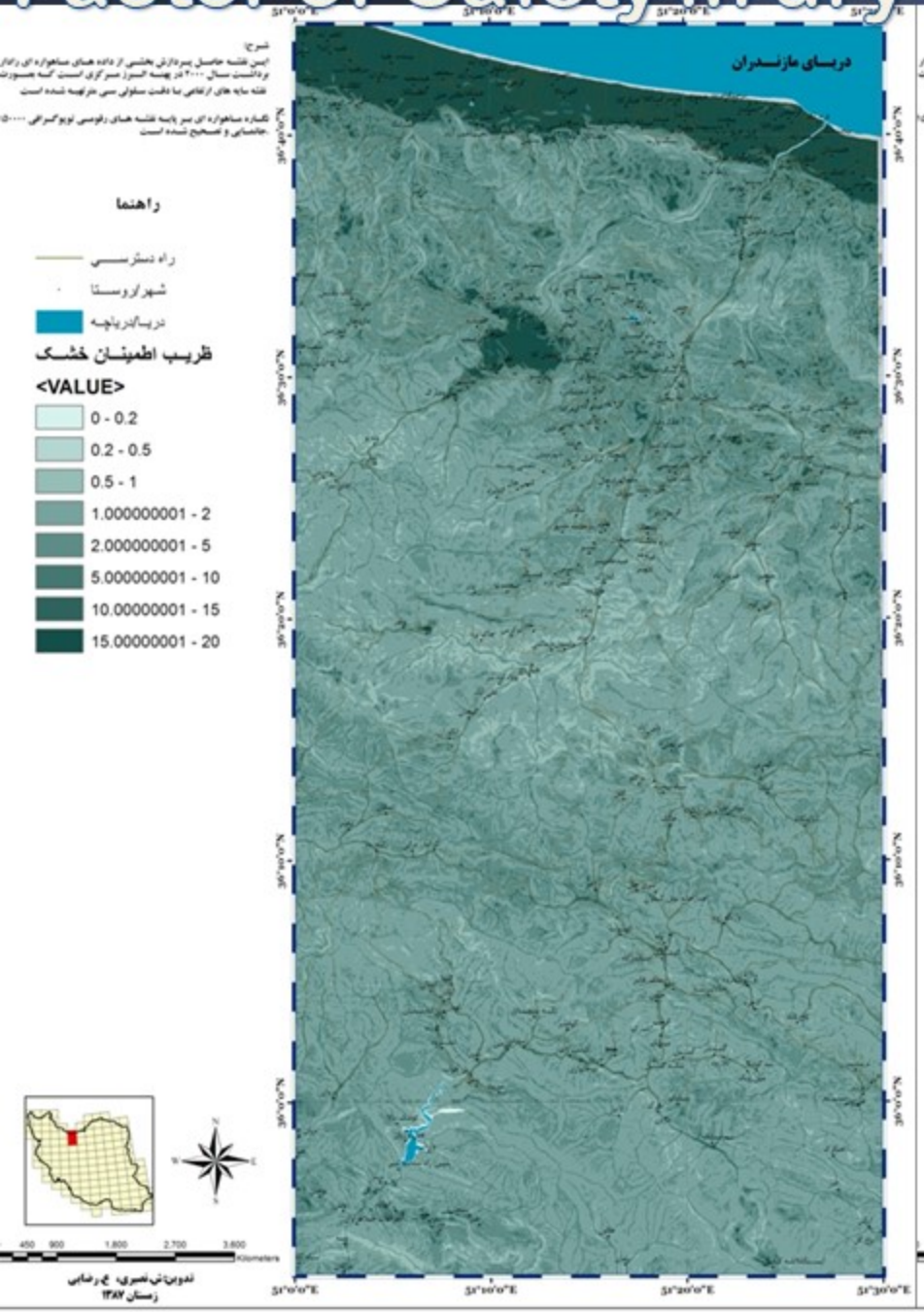
Landslide Database

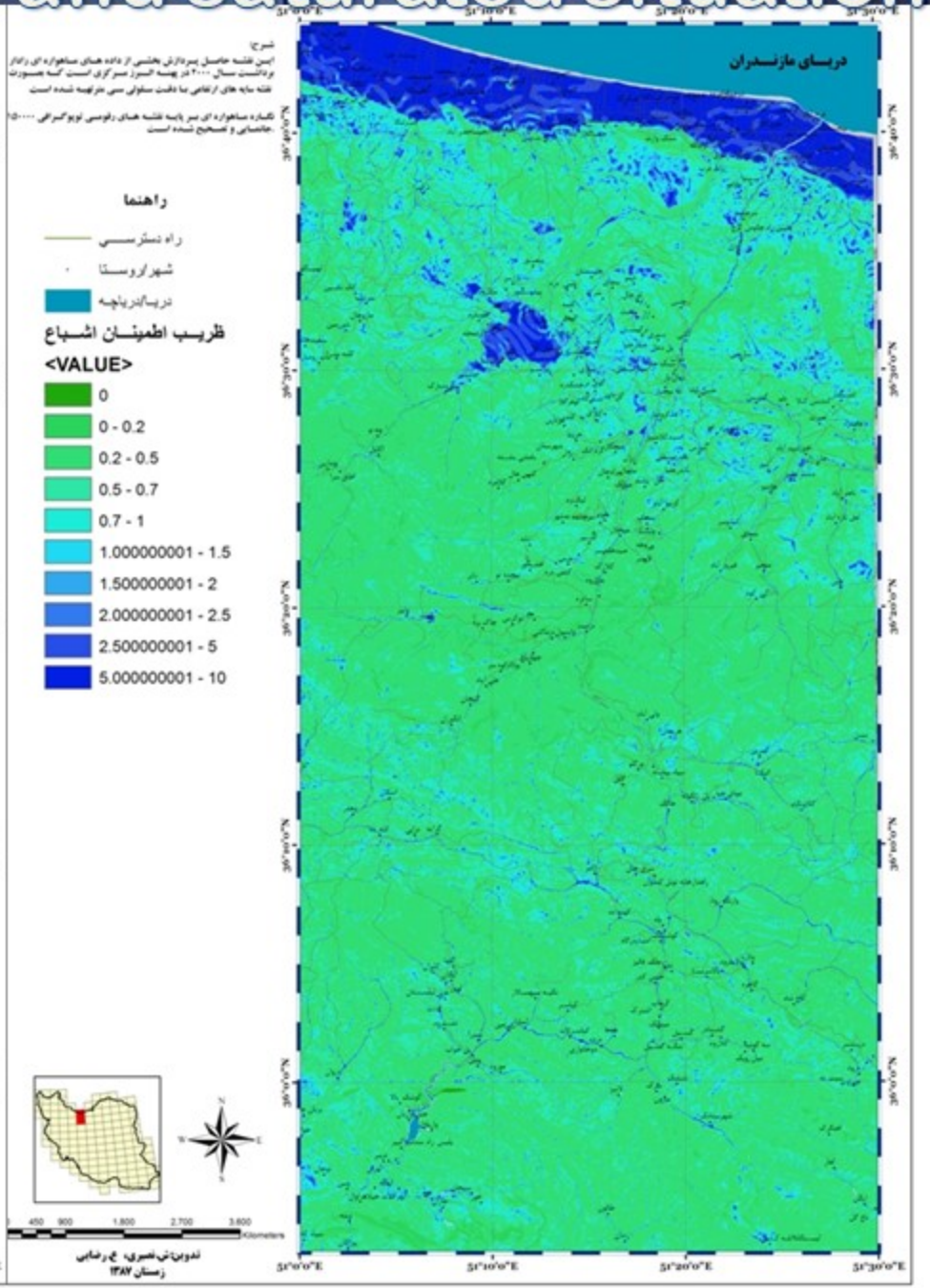
GeoHazard & Sesimic Hazard Mapping





Factor of Safety in dry and saturated situation





RESULTS

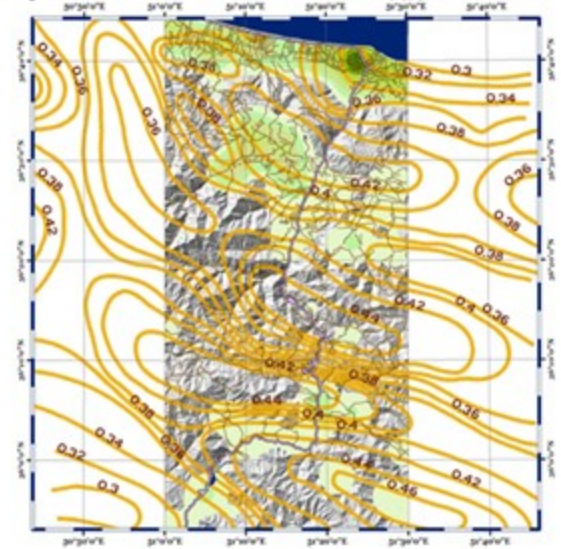
i) the appreciation of 2.9 times in numbers and 3.2 times in volume of displaced materials of landslides.

ii) The introduction of four gigantic prehistoric landslides; one of which embraces the future lake area of the to-be-built Siah-Bisheh Dam which currently disregards this.

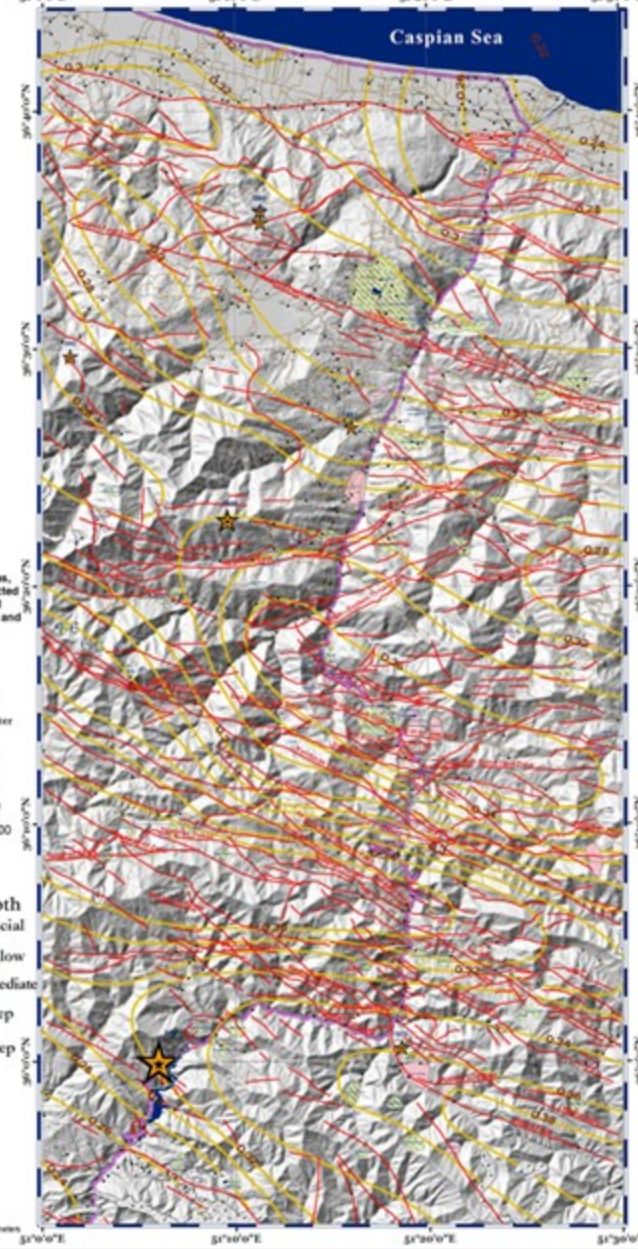
iii) The study is brought to conclusion by landslide hazard zonation map base on new re-assessments.

Earthquake Hazard in Chalus Mountainous Road, Central Alborz Mountain

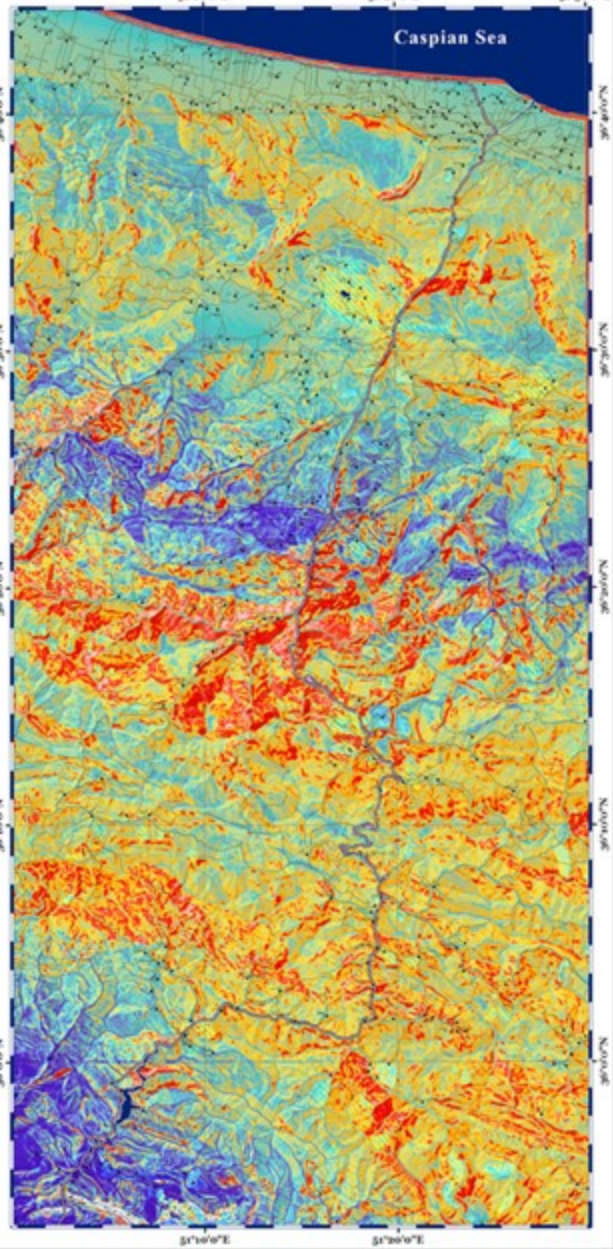
Population & Peak Ground Acceleration Zonation, 475Y Return Period



Landslide Database & Peak Ground Acceleration Zonation with 75Y Return Period



Probabilistic Seismic Landslide Hazard



This Map focuses on seismic risk and slope instability assessments in the Tehran-Chalus road and surrounding areas, Tehran and Mazandaran provinces. Paleolandslides were detected and described, seismic risk assessment (for selected return period) was conducted for various levels of hazard and several datasets were produced such as geotechnical dataset (C & phi) and rock-soil units. Finally potentially unstable slope sediments (glacial deposits) were determined and hazard probability was calculated.

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Newmark Displacement

High : 12

Low : 0

- Quaternary Fault
- Peak Ground Acceleration
- Access Roads
- City/Village
- Sea/Lake

Population

pers per square kilometer

- p < 10
- 10 < p < 50
- 50 < p < 200
- 200 < p <300
- 300 < p < 5400
- 500 < p

Landslide Database

- Glacial Deposits
- Slope Instability in Glacial Deposits
- Infered Landslide
- Well-Defined Landslide

Earthquake Database

Maximum Credible Earthquake

- 3,5 < M < 5
- 5 < M < 6
- 6 < M < 7
- 7 < M

Landslide Depth

- D < 5 metres Superficial
- 5 < D < 15 metres Shallow
- 15 < D < 35 metres Intermediate
- 35 < D < 50 metres Deep
- 50 < D metres Very Deep

Earthquake Hazard in Chalus Mountainous Road, Central Alborz Mountain

National Geoscience Database of Iran
Geological Survey of Iran
Ministry of Industries & Mines

0 2.5 5 10 15 20 Kilometers


Thank
you