وزارت کشور
سازمان مدیریت بحران کشور

پژوهشگاه بین المللی زلزله شناسی و مهندسی زلزله

همایش مدیران بحران

چالش های سامانه های شریان های حیاتی در سوانح طبیعی زلزله و سیل

مرتضی بسطامی

هیات علمی و مدیر گروه مهندسی زلزله شریان های حیاتی

پژوهشگاه بین المللی زلزله شناسی و مهندسی زلزله

Gas network

Breakage of gas transmission pipeline in Taleghan city due to landslide after snow and rain (2018)

Just 20 minutes after landslide, explosion occurred in the gas pipeline in Taleghan city


IRIBNEWS

Damage to buried pipelines
The 2019 flood

We usually do not consider the effect of flood on buried pipeline

Collapse of supports of main gas pipeline in Golestan-Minoodasht, (The 2019 flood)

Water transmission pipelines

Breakage of a water transmission pipeline(Ductile Cast Iron) between Sar-pole-zahab and Qasre-shirin (D=600 mm) in The 2017 Sarpole-Zahab earthquake

This 35 km pipeline was broken in 30 locations

Breakage of GRP(Glass Reinforced Plastic) water transmission pipelines from dam to Bojnourd city

The 2017 North Bojnourd earthquake

Damage to Valves

The 2017 North Bojnourd earthquake

Damage to Valves

The 2017 North Bojnourd earthquake

Breakage of valve in Ductile Cast Iron transmission pipeline in the 2017 Sarpole-Zahab earthquake

Damage to pump station of water network in the 2019 flood(Dehloran)

Water reservoir in Sar-pole-zahab City

Leakage in expansion joint of drinking water reservoir in Sar-pole-zahab City

Water purification plant

Damage to purification plant of Sar-pole-zahab city

Damage to foundation of steel reservoirs in Sar-pole-zahab water purification plant

Collapse of retaining wall of fountain in Sar-pole-zahab water purification plant

Quality of drinking water a few days after earthquake

Quality of water in fountain in Sar-pole-zahab water purification plant because of aftershoks

Quality of drinking water in villages

Wastewater network of Ahvaz suffered damage

Sanitary sewers and surface water have same network

Total length: 2300 km

Old lines: 1100 (50-70 year age)

75 km of old concrete pipelines destroyed in 2019 flood

Performance of Power Electric Networks

Collapse of transmission tower due to rock falling in the 2017 Sar-pole-zahab earthquake

63kV Sar-pole-zahab Substation

Overturning of power transformer

The transformer fell off the rails

Iran-Transfo company was established by Siemens Co. Germany in 1966

Transformator’s wheels are on the rail that doesn’t have enough strength against lateral loads that causes overturning of the transformer

Severe damage to other equipment in 63 kV substation

Severe damage to other equipment in 63 kV substation

Severe damage to control room in the substation

Performance of critical equipments in the 63kV Substation

Equipment	Total	Damaged	Damage Ratio
CT	12	9	75%
CB	4	3	75%
Power transformer	2	1	50%
Line trape	2	2	100%
DS	7	5	71%
CVT	7	7	100%

Aerial transformers fell down in many earthquakes

Power electric poles fell down in the 2013 Shonbe(Bushehr) earthquake- because of corrosion in the reinforcement bars

Corrosion in the reinforcement bars causes insufficient strength against earthquake

Performance of electricity transmission and distribution networks in flood

Transmission towers overturned in flood

Flooded towers and poles

Golestan Province, the 2019 flood

Breakage of electricity power poles in flood

Sistan and Balochesatn Province, 2019(Jan) Flood

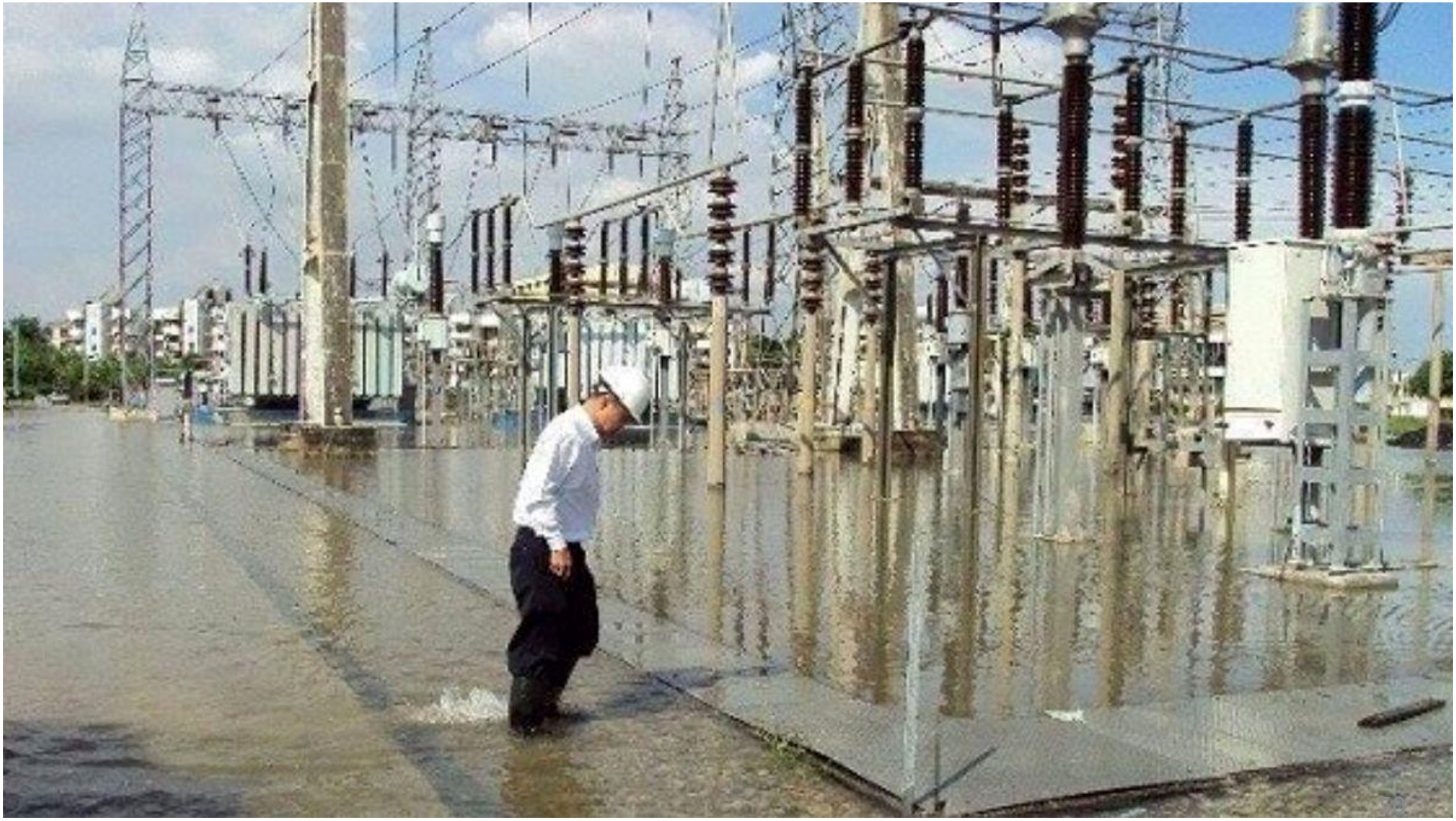
Sistan and Balochesatn Province, 2019(Jan) Flood

Emergency restoration of damaged electricity distribution network inside water(the 2019 flood)

Power planets and Substations

Power planets and Substations

Some of them flooded but no black out due to malfunction of power planets and substations



Flooded Substation and construction of first levee for protection of substation

Transportation systems

Performance of Bridges in 2013 Borazjan earthquake(Mw=5.7)

A new long bridge in new road between Bushehr and Ahvaz damaged in a 5.7 earthquake!

Liquefaction and sand-boiling occurred under foundations of the bridge that caused settlement in the bridge

Liquefaction and sand-boiling occurred under foundations of the bridge that caused settlement in the bridge

Severe damage to beam and shear key

Collapse of bridges in the 2019 West Flood(Kermanshah)

The 2018 North Flood(Gilan-Asalem)

The 2016 East Flood (Jahroom)

Scouring of bridge pier in 2013 flood(Bushehr)

Ya Zahra Bridge(Iilam)

Vahdat-Abad Bridge(Iilam)

Dams: performed vey well to control flood

Gas stations: many flooded

Roads

10750 km of roads were damaged.
7791 km of rural and 2959 km of main roads
111 km of railroads were damaged

Main road of Abadan to Khoram-shahr was flooded

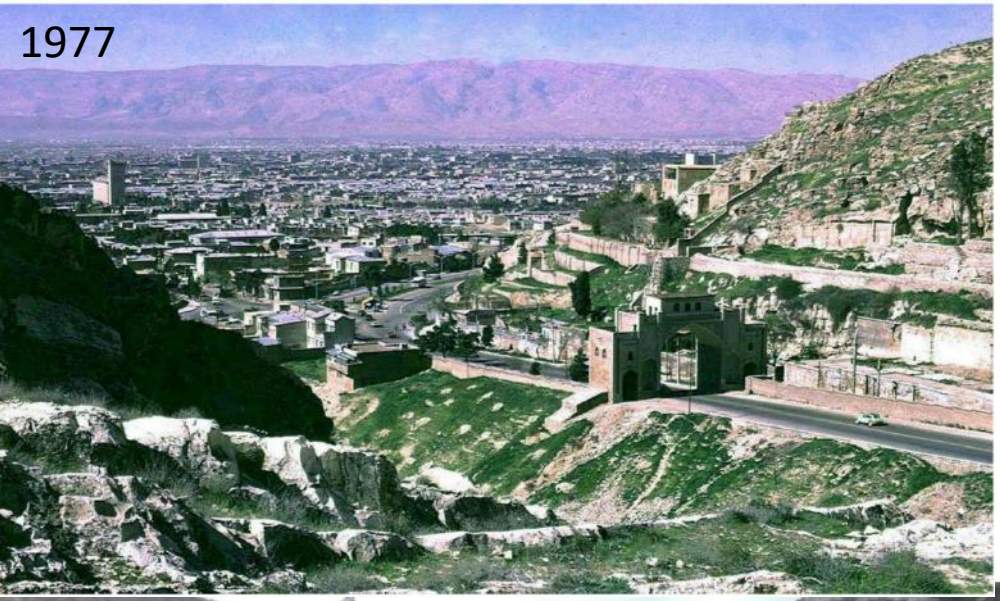
Gonbad Kavus city

Damage to road and buried facilities of telecommunication network

Flooded entrance road to Shiraz

21 died and 119 injured

The flood had taken away more than 200 cars



Just a pipeline by diameter
of 1 meter to transfer the flood!

Damage to roads(Ahvaz)

Landslide next to exit of road tunnel
(The 2019 flood)

Destruction of railway due to landslide
(The 2019 flood)

They destroyed a part of railway to open a path for flood!

Damage to railway and stations

شکل ۳-۲۹ خسارت بلاک آهو دشت- بامدژ (کیلومتر ۷۶۳- ۷۶۶+۸۰۰)

Flooded Airport of Gorgan

Destruction of flood-wall in Khoram Abad City, Insufficient design, The 2019 flood

شکل ۲-۳۷ محل اتصال دیوار ساحلی سنگی ملاتی و بتنی و همچنین حجم تخریب صورت گرفته.

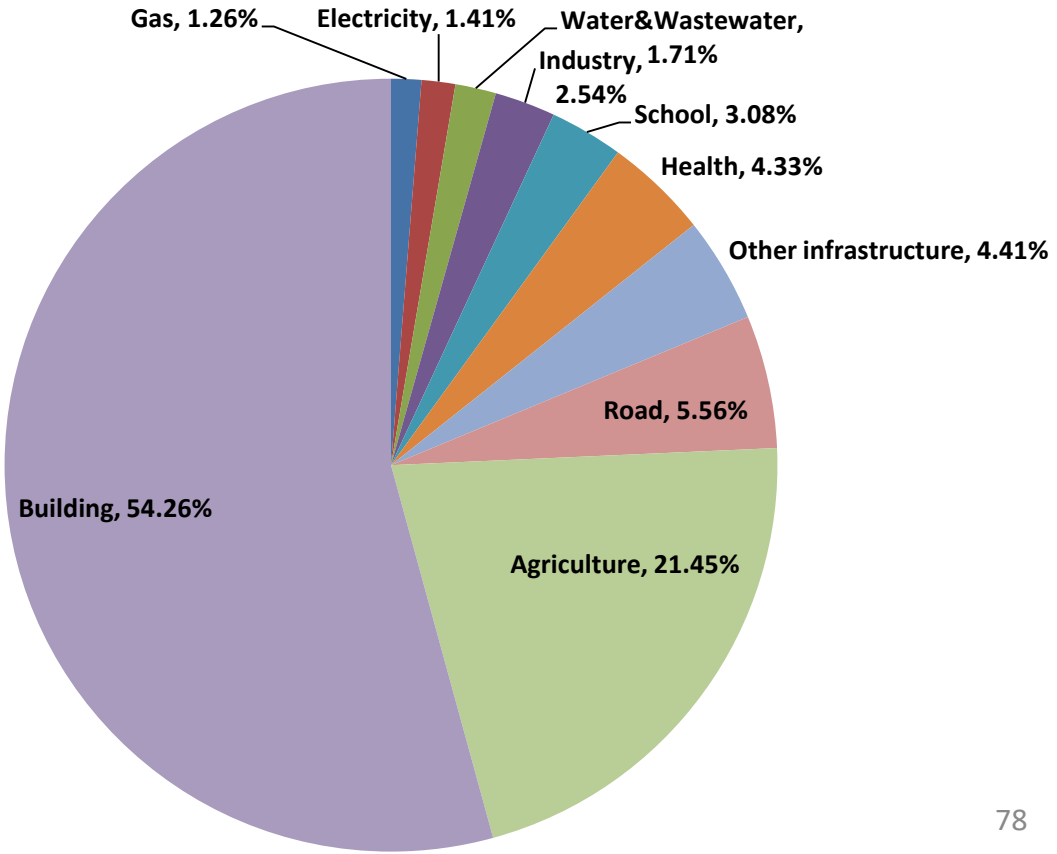
Flood transferred out of channel!

Insufficient design

A comparison between losses of infrastructures in earthquake and flood

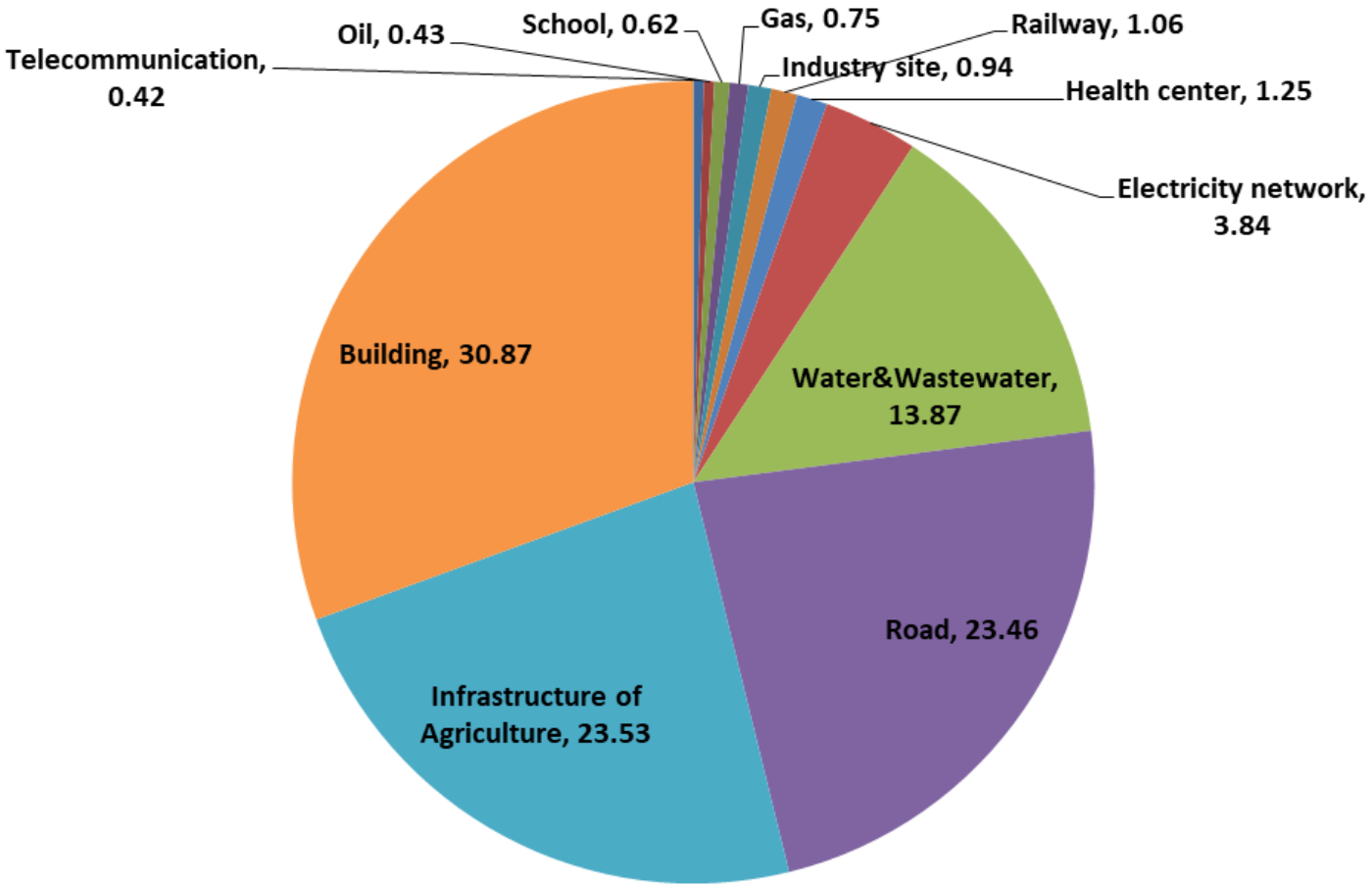
Loss of sectors(the 2011 Ahar-Varzaghan Earthquake)

- Total direct loss: $1 Billion
- Loss of infrastructures: $0.46 Billion (45.7%)
- Damages were in 3 small cities

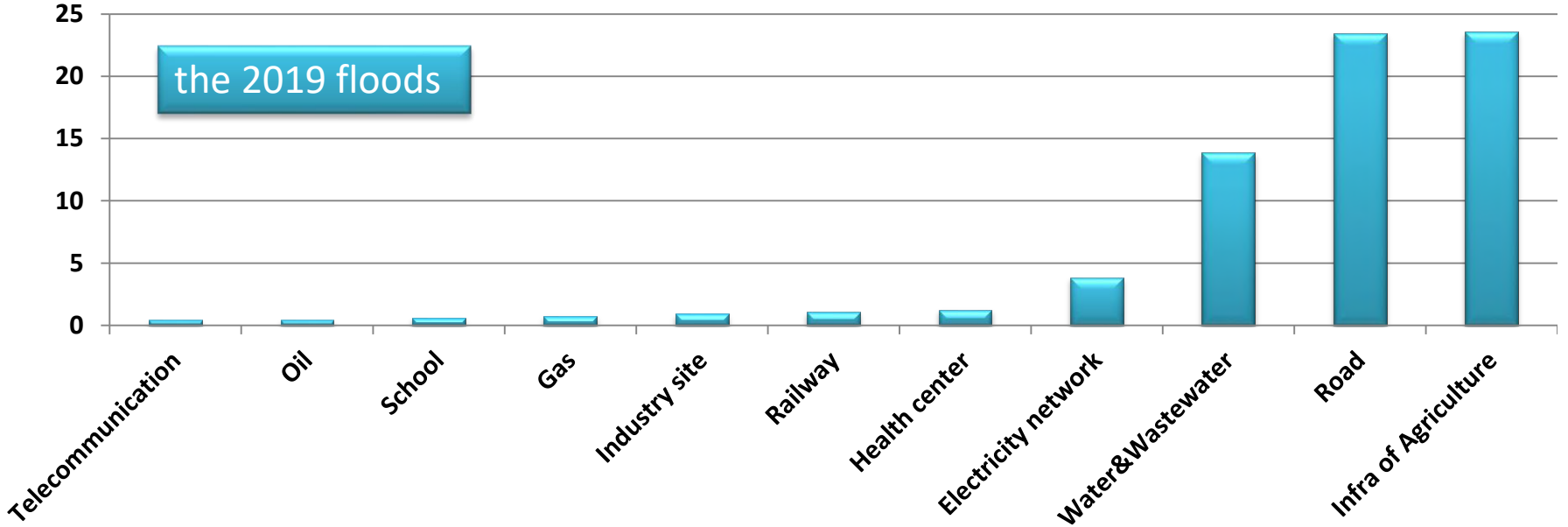


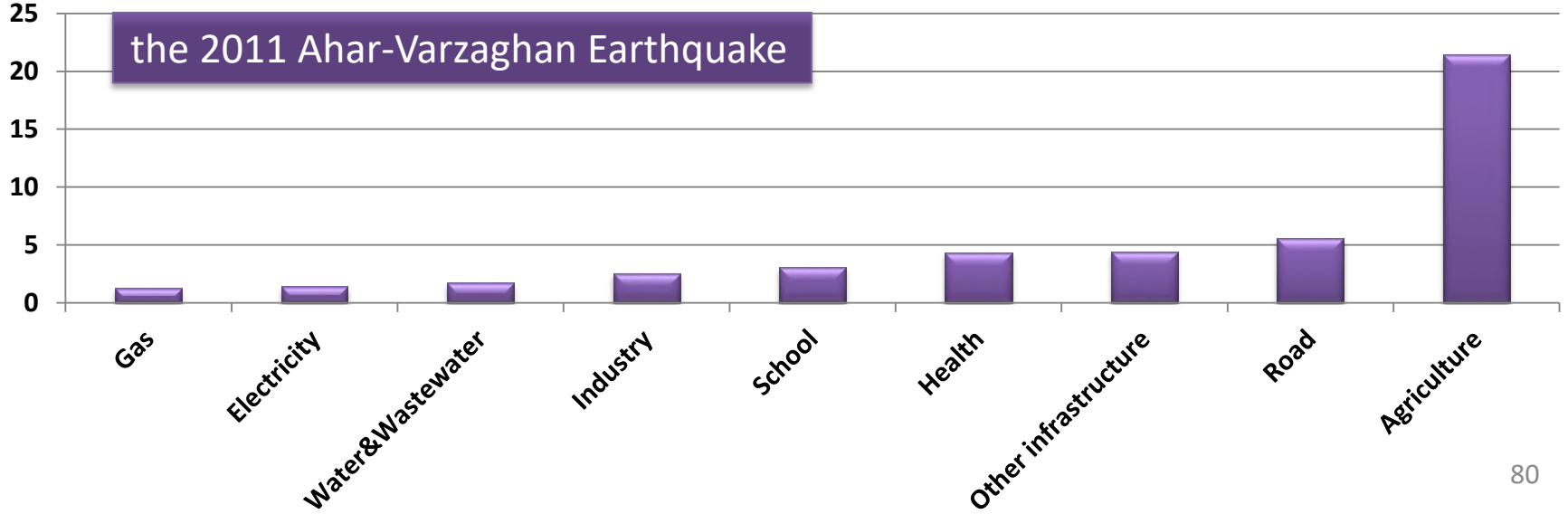
Loss of sectors(the 2019 Floods)

- Total direct loss: $4-5 Billion
- Loss of infrastructures: $2.8-3.5 Billion (69.13%)

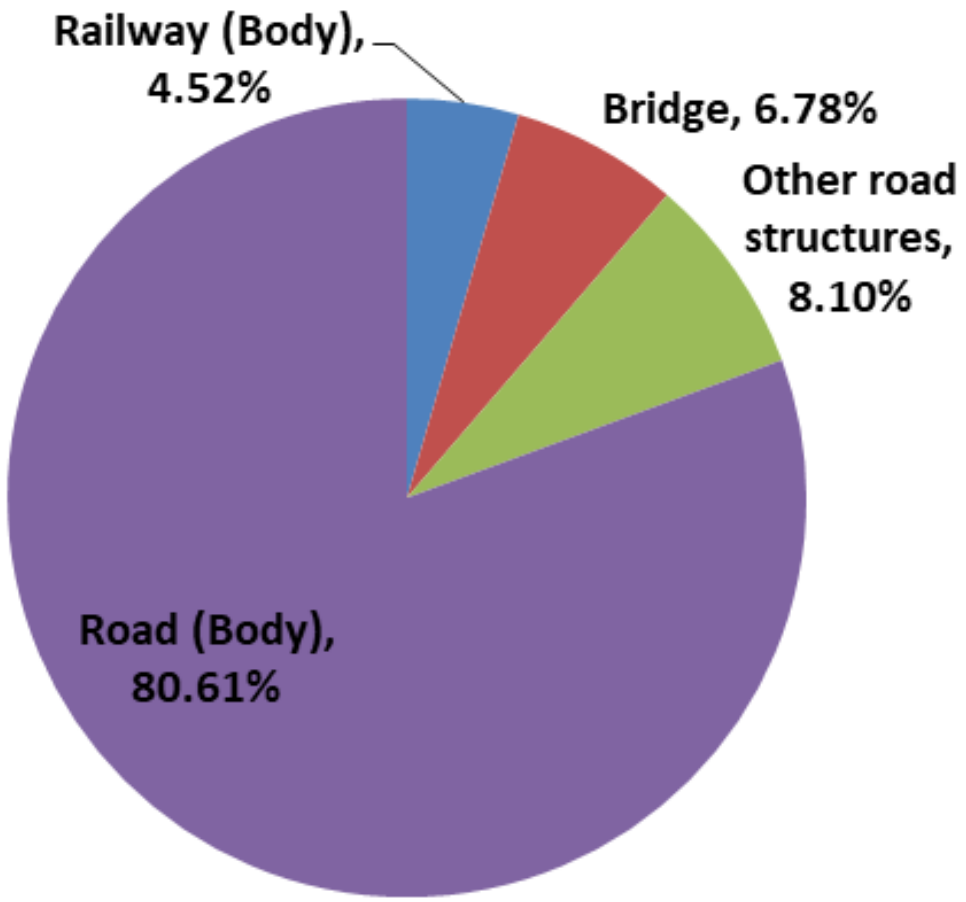


Comparison of loss of Infrastructures(the 2019 floods and the 2011 Ahar-Varzaghan Earthquake)





Loss of roads (the 2019 Floods)

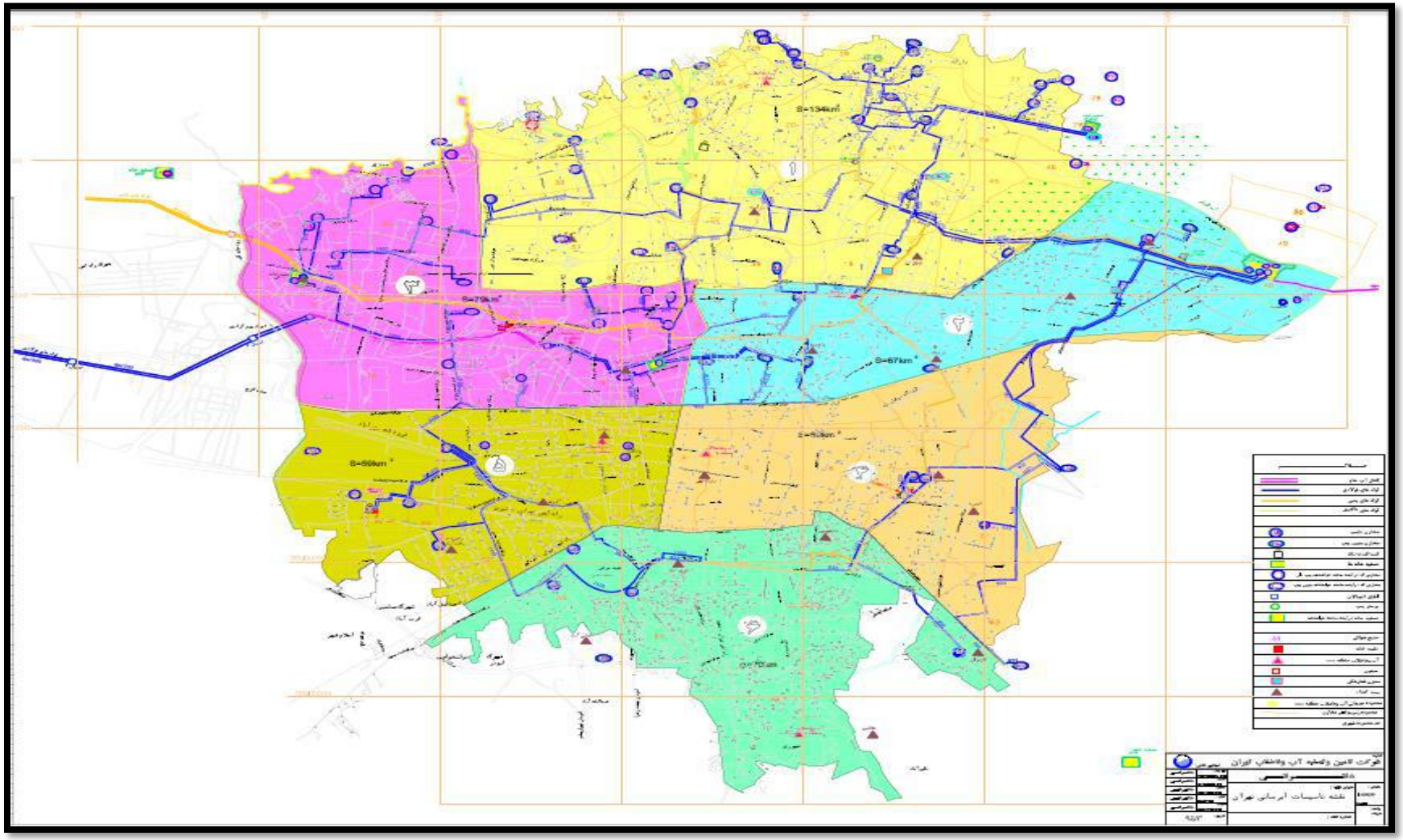


Portion of road body in earthquake is almost zero

تجربیات ما در زمینه بهسازی و مقاوم سازی زیرساخت ها

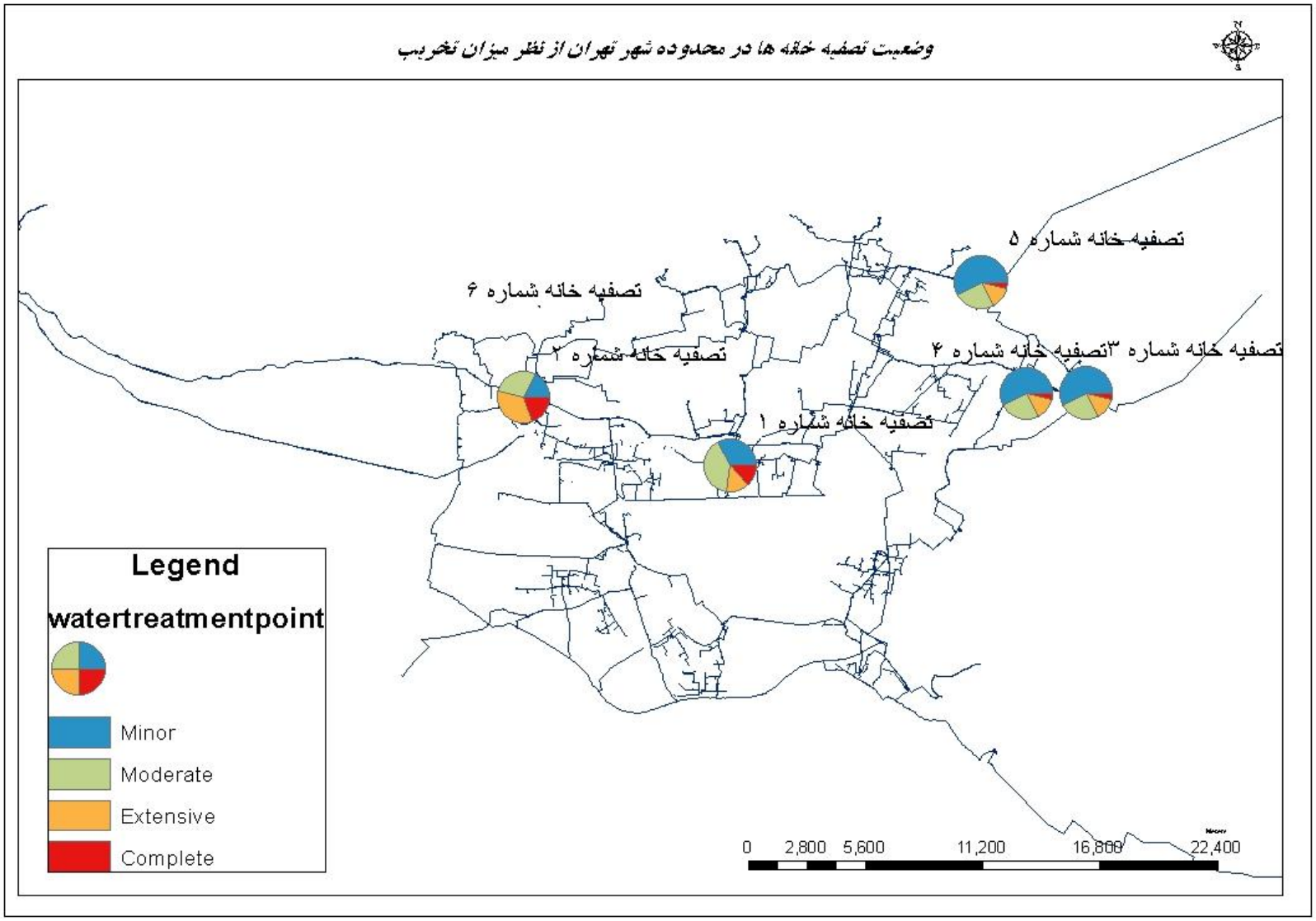
- شبکه و نیروگاه برق
- شبکه و تاسیسات گاز
- شبکه و تاسیسات آب
- شبکه فاضلاب
- پل ها
- تاسیسات نفتی
- پالایشگاه ها
- سدها
- بیمارستان ها
- مدارس
- ...

Districts map of Tehran water company

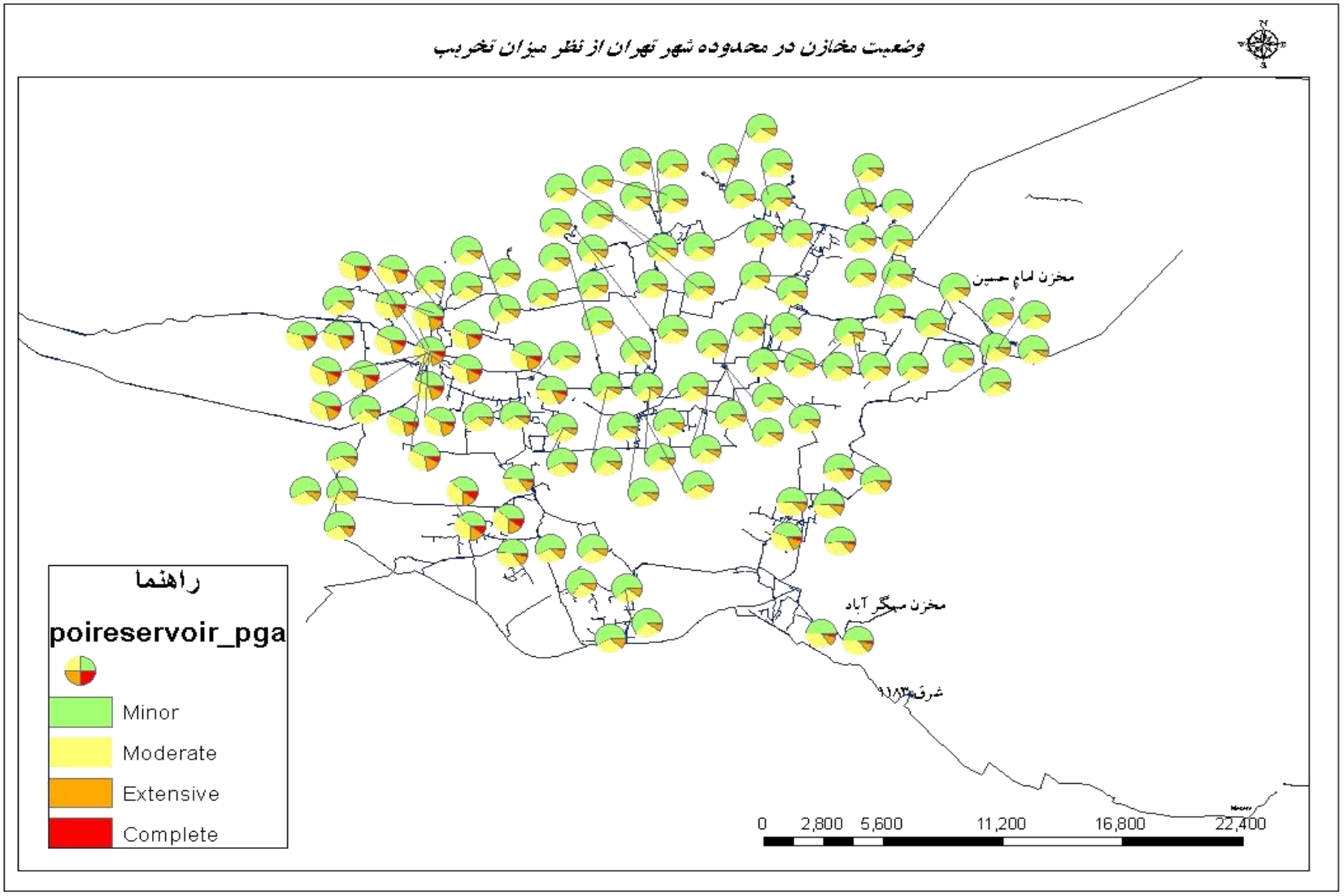


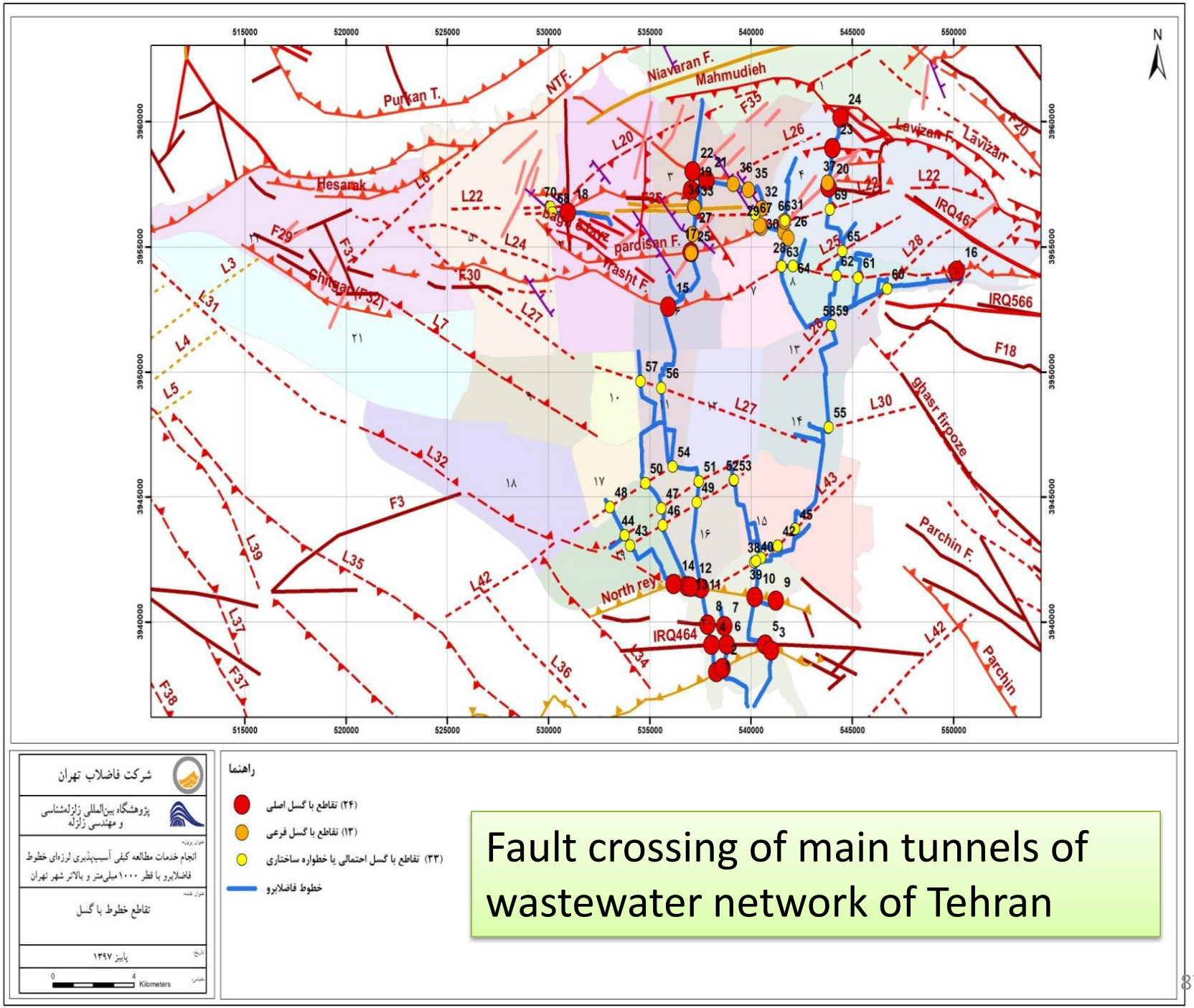
Tehran water purification plants

Probability of damage to water purification plants in different earthquake scenarios



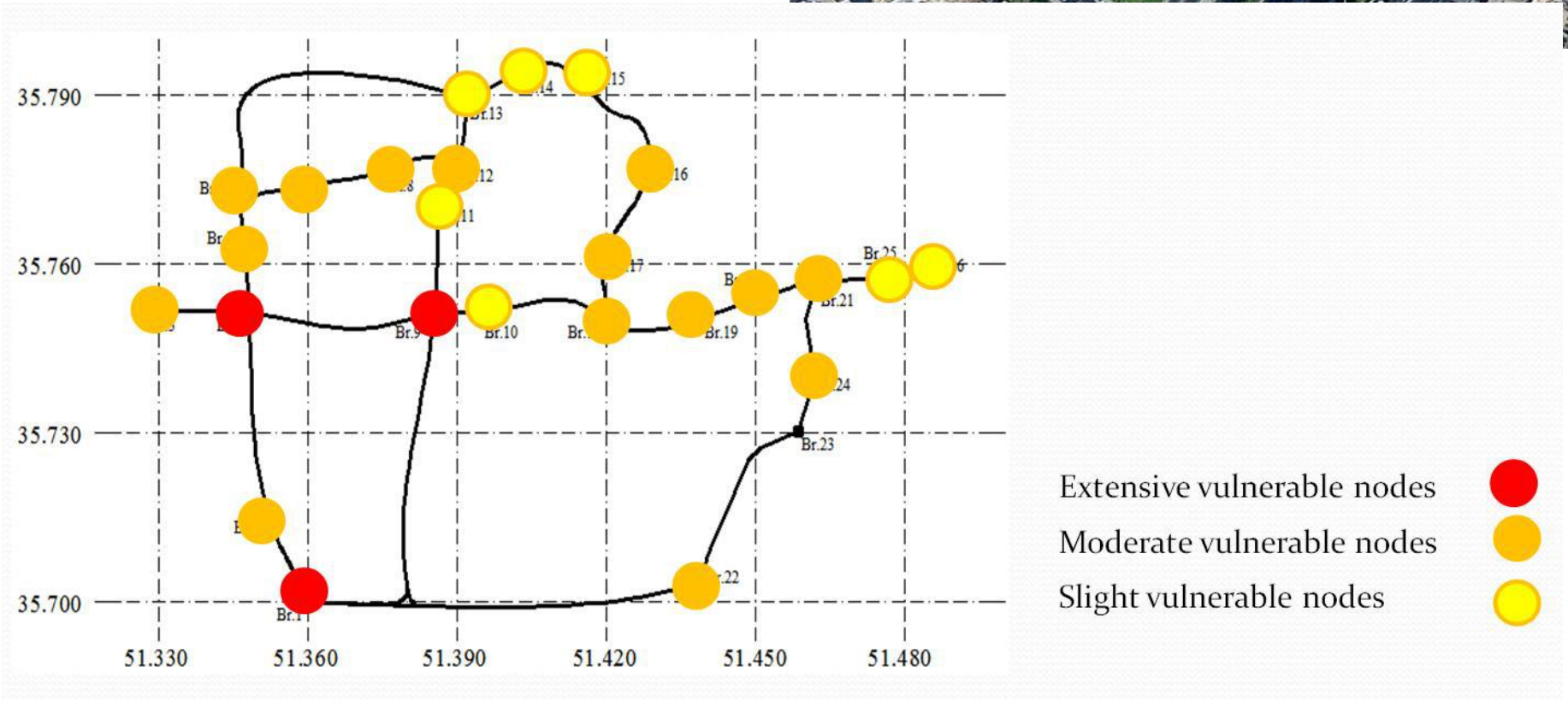
Probability of damage to reservoirs in different earthquake scenarios



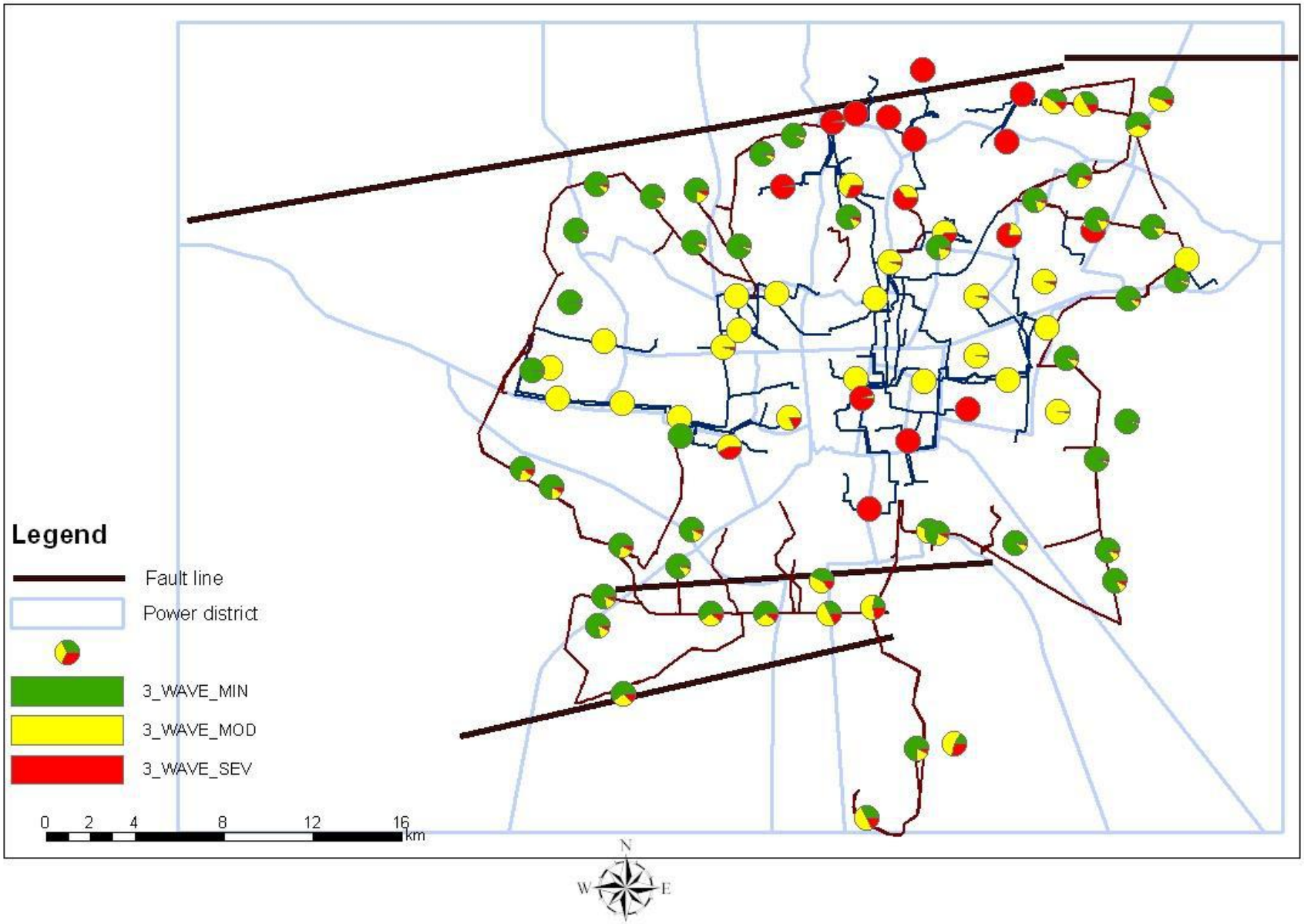


Fault crossing of main tunnels of wastewater network of Tehran

Damage assessment of bridges in north-west of Tehran by extreme scenario method



Tehran Electricity Network
Probability of damages at some 63 kV lines



Experimental tests on infrastructures components

Test of emergency valve on shaking table

Advanced Laboratories

Soil Dynamic Lab. & Physical Modeling

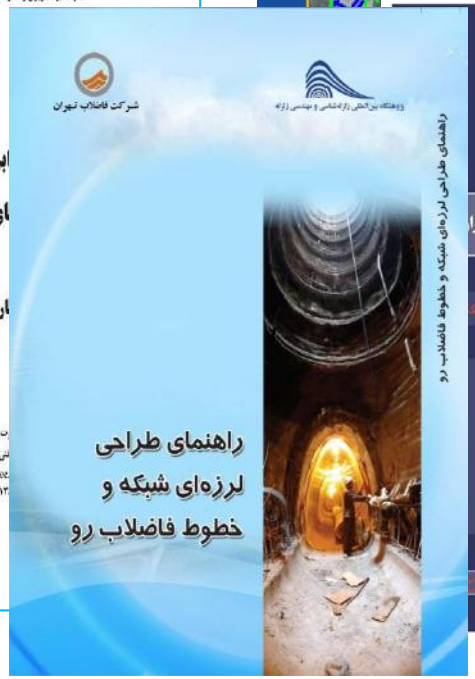
Test of pipelines and tunnels in Centrifuge Testing Facilities

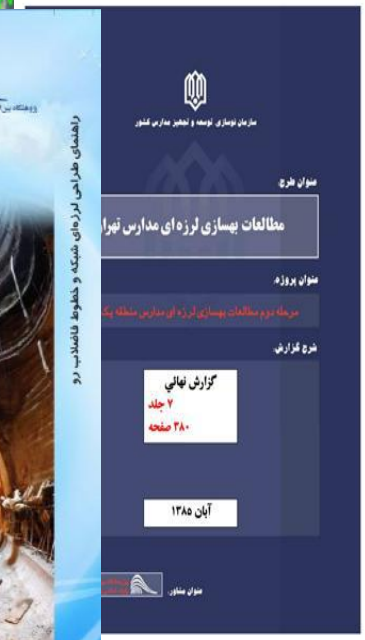
Structural Dynamic Lab. & Shaking Table

The best laboratories in the west of Asia for large scale tests

Vulnerability Assessment & Retrofitting

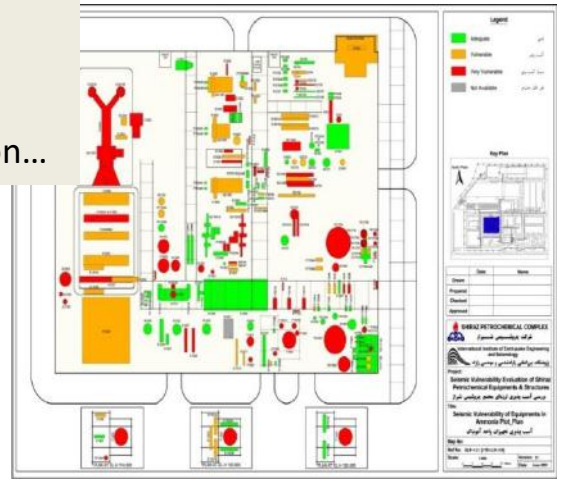
Guidelines

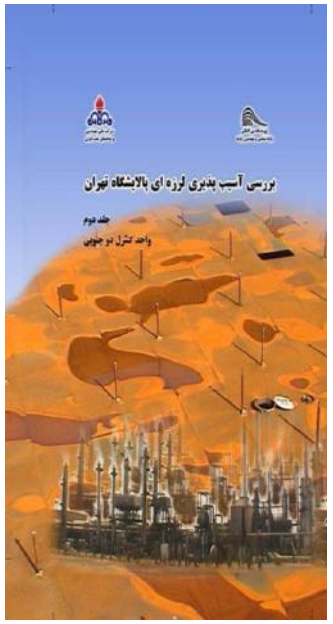


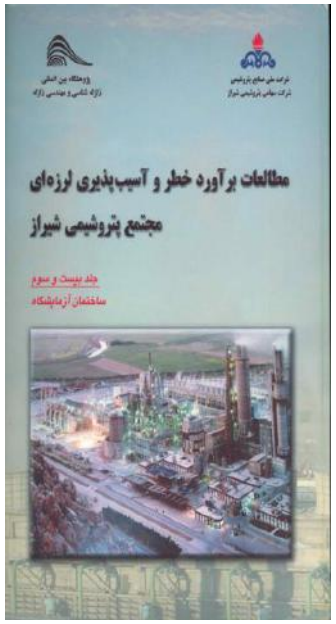


Projects

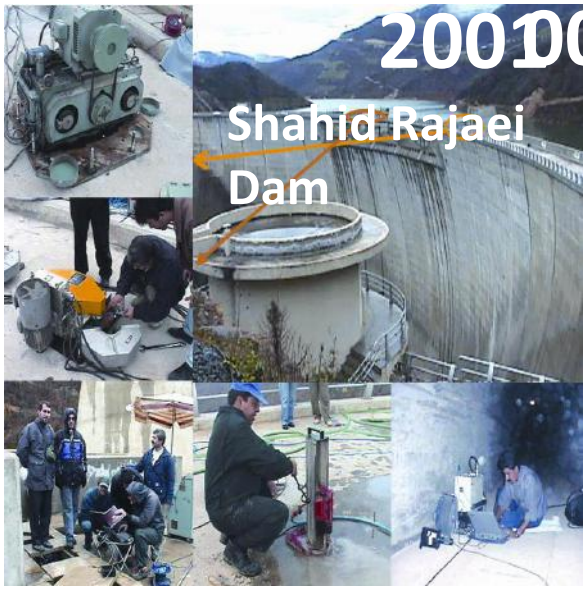
Hospitals, Schools, Water, Power, Oil, Gas, Industrial Plants, Telecommunacation…







Health Monitoring of Infrastructures



جمعبندی

- عملکرد کلی سامانه های شریان های حیاتی شامل حمل و نقل(جاده ای و ریلی)، برق، آب، فاضلاب و تا حدی مخابرات و گاز قابل قبول نبود.
- این سامانه ها نیاز به مطالعات تحلیل خطر و تحلیل ریسک در برابر مخاطرات چندگانه دارند.
- دستگاه های متولی هر یک از سامانه ها موظف به اقدامات مقاوم سازی برای بخش های مهم آنها مبتنی بر نتایج مطالعات بند ۲می باشند.
- دستگاه های متولی موظف به تدوین برنامه های پاسخ و بازسازی اضطراری این سامانه ها مبتنی بر نتایج مطالعات بند ۲می باشند.