GLOBE INTERNATIONAL VIRTUAL SCIENCE SYMPOSIUM

Aquatic macroinvertebrates and their importance as water quality bioindicators in the Chimehuín River, Patagonia, Argentina.

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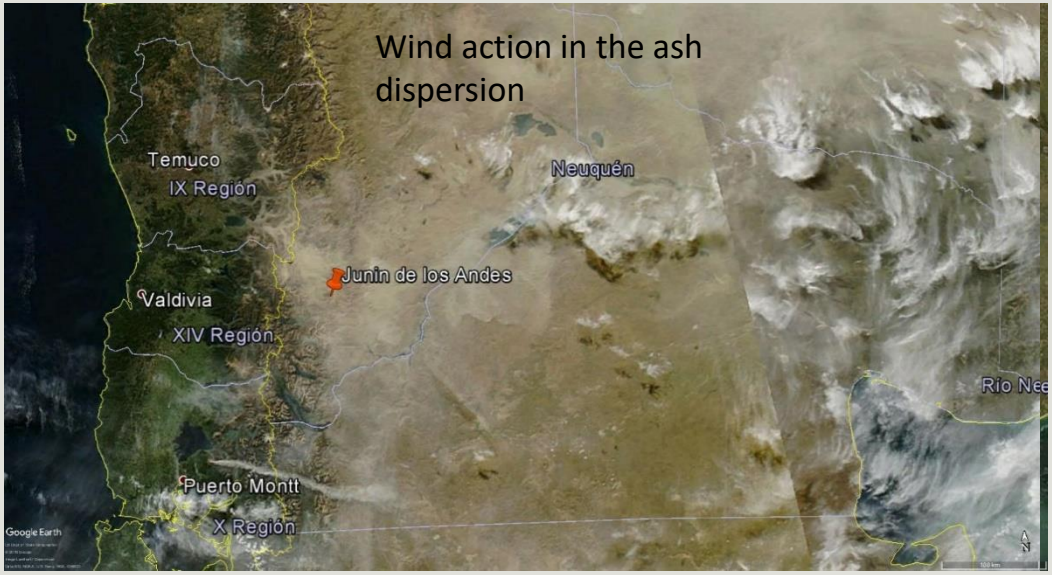
Teacher: Prieto, Ana Beatriz

Source: http://www.cronicalibre.cl/2016/04/22/a-un-ano-de-la-erupcion-del-volcan-calbuco-vecinos-de-lago-chapo-realizaron-balance/

Introduction



In April 2015 Calbuco volcano erupted, scattering a large amount of ash

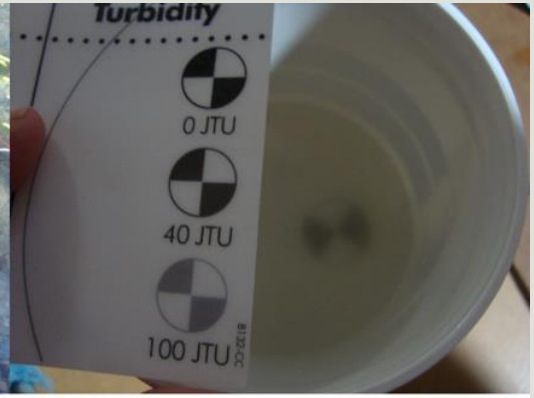
This impacts ecosystems and human activities: land and air transport (over long distances), communications, infrastructure, agricultural activities, health, water sources.

It is necessary to remove the ash to resume daily activities.

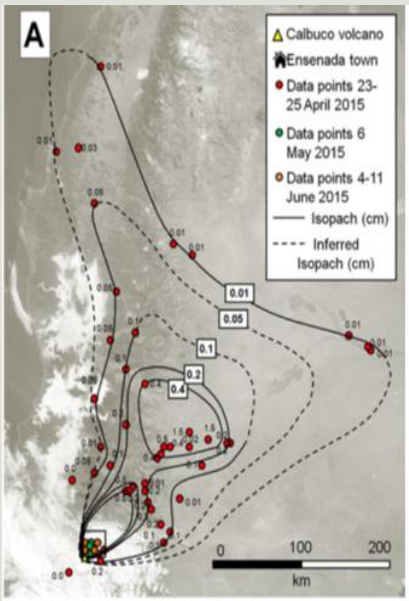
Most of the ash dispersed in the hills will be introduced into the soil only with the rains.

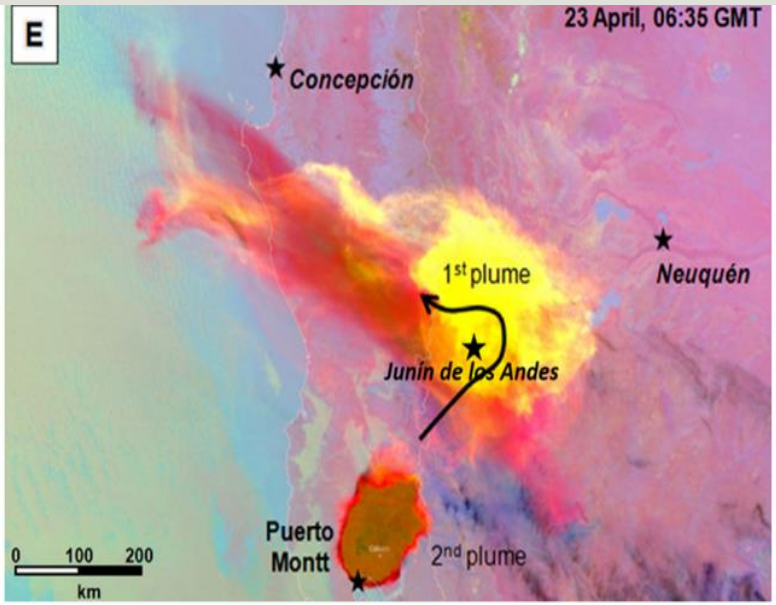
Chimehuín river with volcanic ash in the banks and the surrounding terrestrial area.

Sedimentation of volcanic ash on the bed of river stones



Water turbidity. Generally the turbidity is 0, only changes by the runoff after the rains





Modified. Source: Romero, J. E., Morgavi, D., Arzilli, F., Daga, R., Caselli, A., Reckziegel, F. & Perugini, D. (2016). Eruption dynamics of the 22–23 April 2015 Calbuco volcano (Southern Chile): Analyses of tephra fall deposits. Journal of Volcanology and Geothermal Research, 317, 15-29.

Ash accumulated in the soil after 6 months of the eruption of the Calbuco volcano.

Introduction: sedimentation

Before the eruption of the Calbuco Volcano

After the eruption of the Calbuco Volcano

Research Questions and Hypothesis

Research Questions:

1. How does the ash fall affect water quality and macroinvertebrate populations?
2. How will the anthropogenic impact of land use (with ash) affect the river, water quality, and macroinvertebrate populations?
3. Are there any long-term impacts of ash fall?

Hypothesis:

H1: The fall of volcanic ash affects the diversity of macrobenthic populations.

H2: The anthropic impact around the river contributes sediments to the water causing a greater impact on macroinvertebrate populations

H3: In the long term, populations of macroinvertebrates recover from the impact caused by the fall of volcanic ash.

Chimehuin River

The Chimehuín River basin is one of the most important in the Lanín National Park because it contributes 23% of riverside environments.

The river supplies water to the city and rural areas.

The flow increases by rains in winter and by thaw in spring.

The lowest flow occurs in summer and early fall, when it is most used by fishermen, bathers, campers and others.

Volcanoes in Patagonia

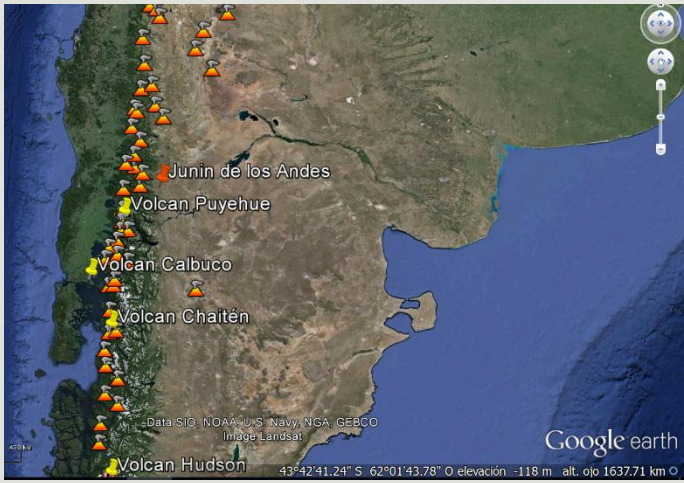
The Calbuco volcano has a long history of eruptions in 1792, 1845, 1893, 1894-95, 1906-07, 1917, 1927, 1929, 1932, 1945, 1961, 1972 and 2015.

In recent years there have been volcanic eruptions of great magnitude:

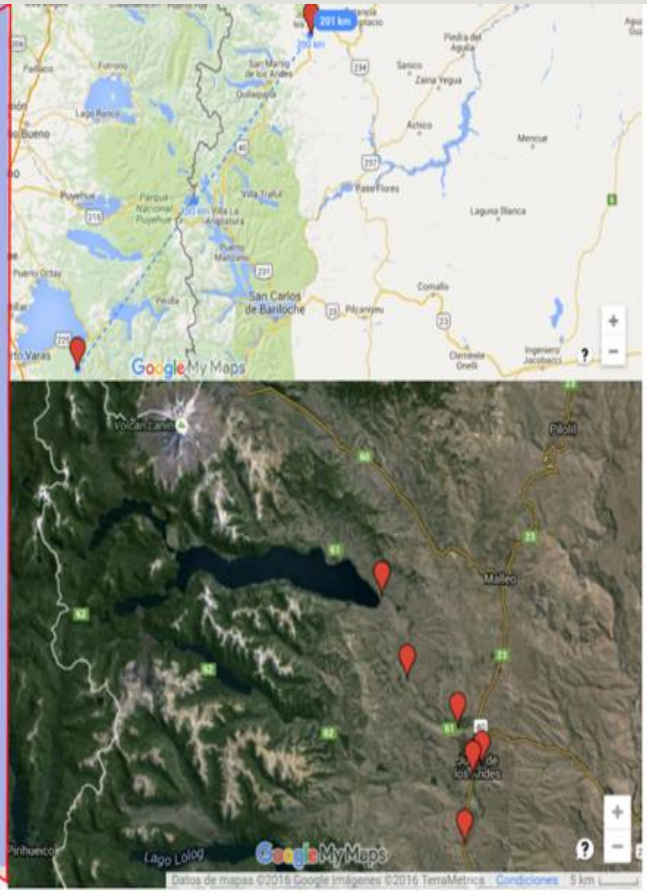
- Puyehue Volcano, in 2011
- Chaitén Volcano, in 2008
- Hudson Volcano, in 1991

Impacts on terrestrial and aquatic ecosystems have been documented, with different degrees of affectation:

1. Diseases in domestic and wild herbivores
2. Losses of agricultural production
3. Changes in the populations of:
   - Phytoplankton and zooplankton in rivers and lakes
   - Trichoptera and other macroinvertebrates in Andean rivers
   - Native and exotic terrestrial arthropods



Methodology: Sampling sites



Straight-line distance from the Calbuco Volcano Junin de los Andes 200 Km.

Sites of macroinvertebrate sampling in the Chimehuín river

Summers:
2015
2016
2017

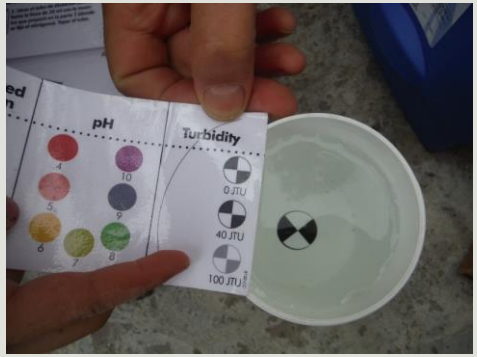
Methodology: Physico-chemical analysis

Dissolved oxygen

Nitrates

pH

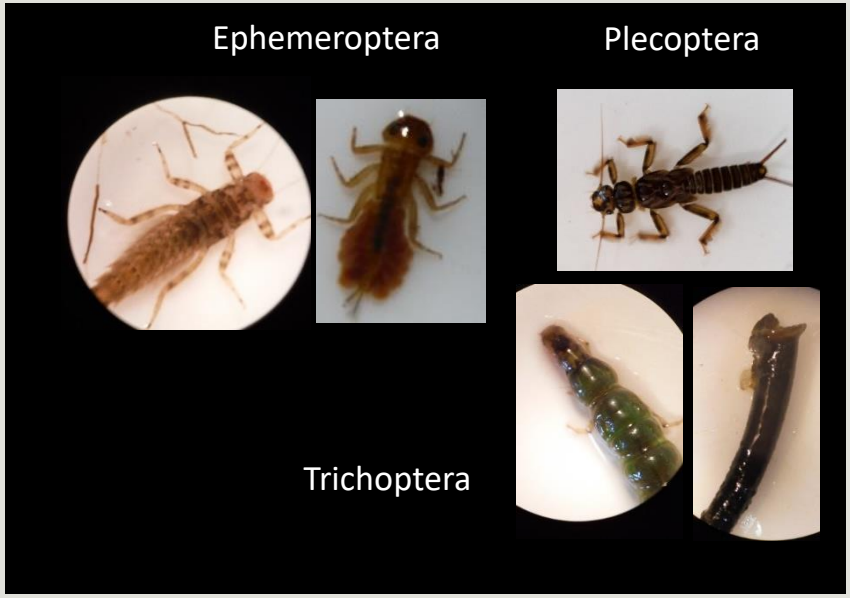
Alkalinity



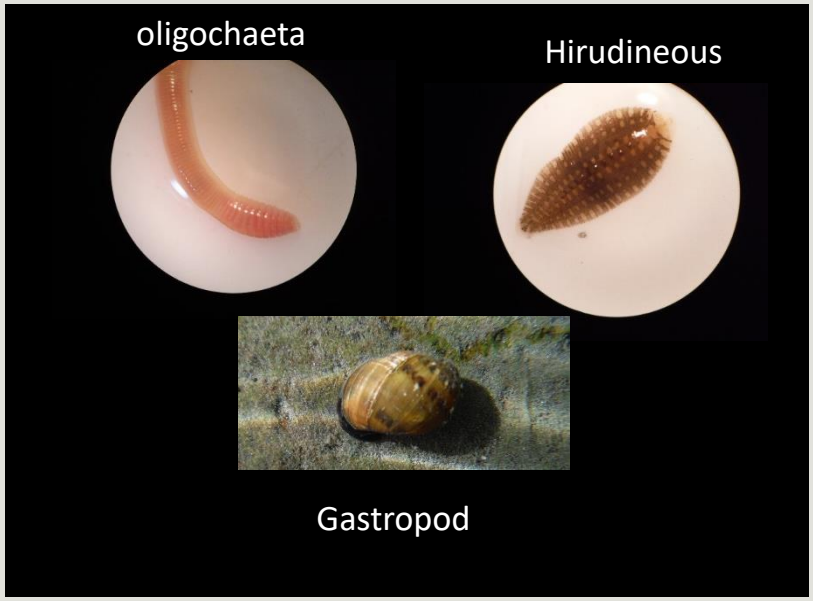
Turbidity

Methodology: Sampling benthic macroinvertebrates

Sensitive species (EPT)



Tolerant species

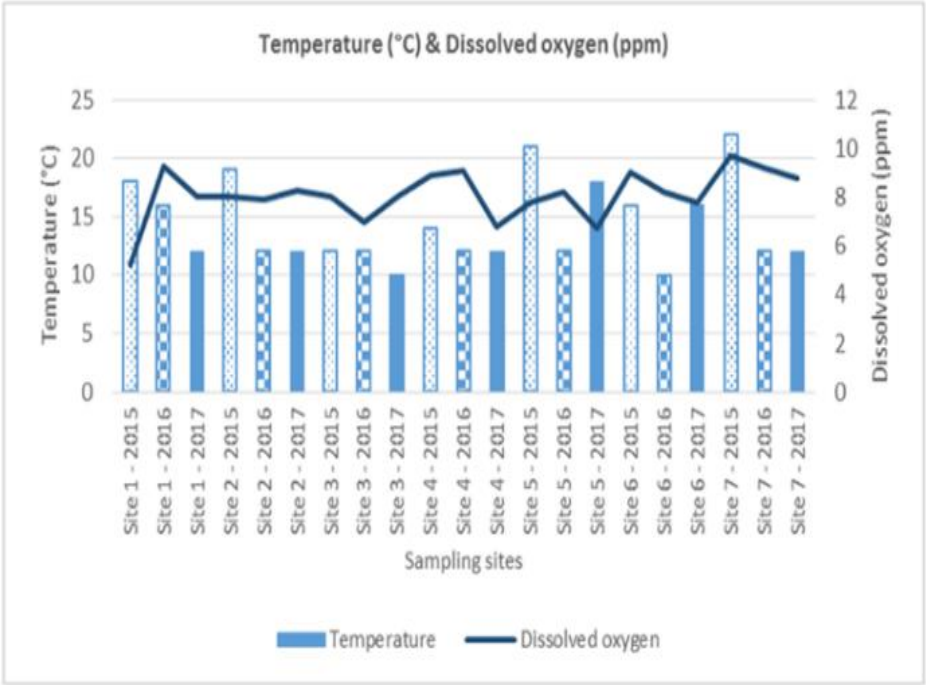


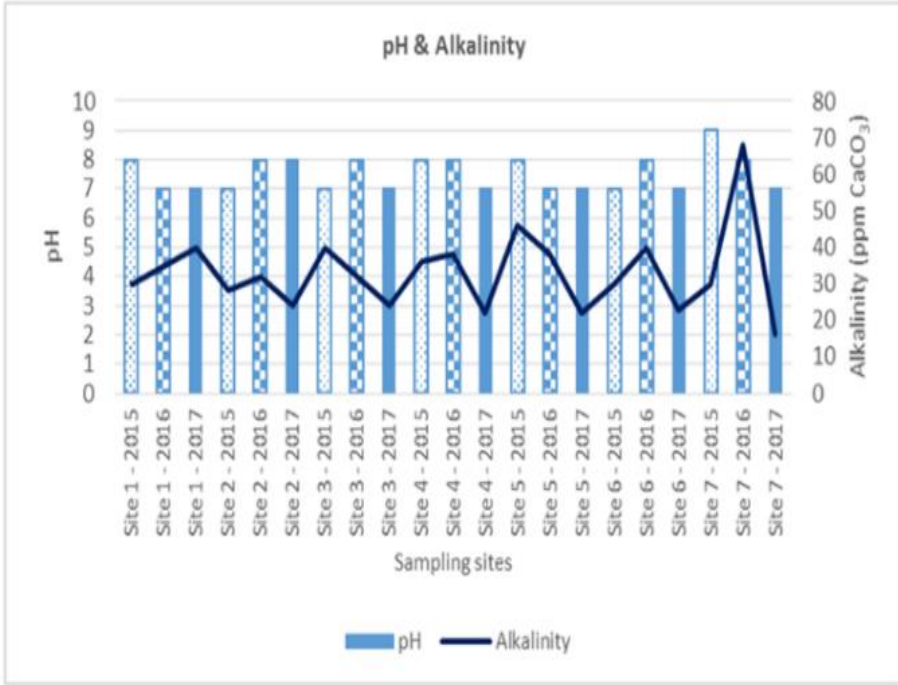
Results

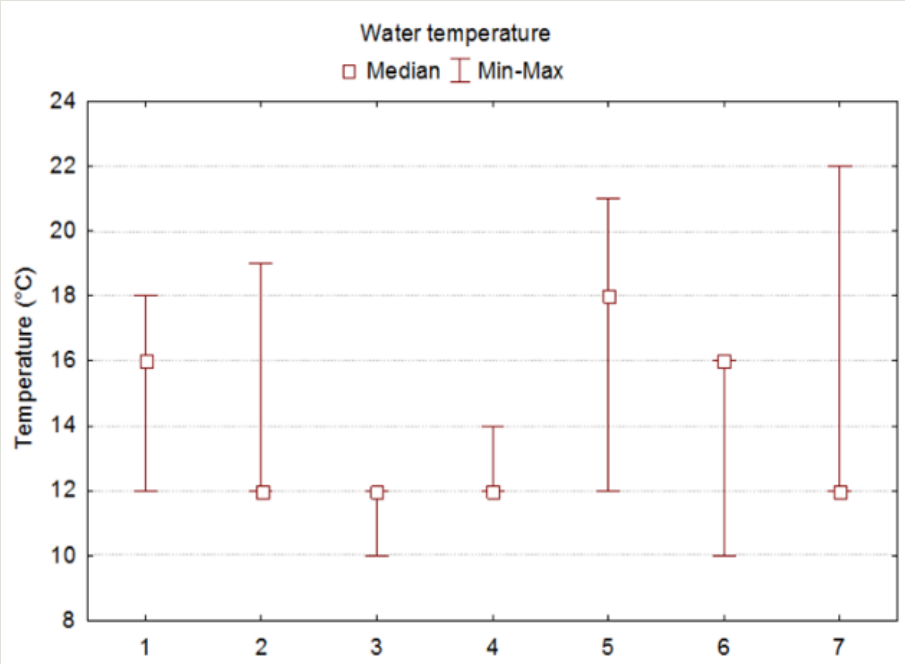
Place	Site 1 - 2015	Site 1 - 2016	Site 1 - 2017	Site 2 - 2015	Site 2 - 2016	Site 2 - 2017	Site 3 - 2015	Site 3 - 2016	Site 3 - 2017	Site 4 - 2015	Site 4 - 2016	Site 4 - 2017	Site 5 - 2015	Site 5 - 2016	Site 5 - 2017	Site 6 - 2015	Site 6 - 2016	Site 6 - 2017	Site 7 - 2015	Site 7 - 2016	Site 7 - 2017
Temperature	18	16	12	19	12	12	12	12	10	14	12	12	21	12	18	16	10	16	22	12	12
Dissolved oxygen	5,2	9,3	8	8	7,9	8,3	8	7	8	8,9	9,1	6,8	7,8	8,2	6,7	9	8,2	7,8	9,7	9,2	8,8
Turbidity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pH	8	7	7	7	8	8	7	8	7	8	8	7	8	7	7	7	8	7	9	8	7
Alkalinity	30	35	40	28	32	24	40	32	24	36	38	22	46	38	22	30	40	23	30	68	16
Nitrates	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2
Gastropods	2	80	118	36	15	5	201	89	225	12	29	103	88	27	105	20	80	111	121	26	256
Trichoptera	45	14	43	6	23	11	16	21	22	1	25	10	4	11	16	31	48	5	83	72	7
Plecoptera		0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Ephemeroptera	24	91	32	58	46	107	71	61	25	6	16	40	172	38	41	50	76	6	41	73	63
Decapoda	0	2	0	0	2	0	0	1	0	0	1	0	3	1	0	0	0	7	9	0	10
Diptera	3	0	0 (*)	8	1	9	0	0	0	0	0	1	1	12	2	7	12	2	0	0	0
Oligochaeta	0	0	1	0	0	0	0	1	0	0	0	0	0	1	4	0	0	0	0	0	0
Turbellaria	0	0	0	0	3	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	0	0	18	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Total macroinvertebrates	74	187	212	108	90	136	290	174	272	19	71	154	268	90	169	108	216	133	254	171	336
Dominant taxon	Trichoptera	Epheme roptera	Gastro pods	Epheme roptera	Epheme roptera	Epheme roptera	Gastro pods	Gastro pods	Gastro pods	Gastro pods	Gastro pods	Gastro pods	Epheme roptera	Epheme roptera	Gastro pods	Epheme roptera	Gastro pods	Gastro pods	Gastro pods	Epheme roptera	Gastro pods
Number dominant taxon	45	91	118	58	46	107	201	89	225	12	29	103	172	38	105	50	80	111	121	73	256
% Dominant Taxon	61	49	56	54	51	79	69	51	83	63	41	67	64	42	62	46	37	83	48	43	76
Total EPT	69	105	75	64	69	118	89	82	47	7	41	50	176	49	57	81	124	12	124	145	70
% EPT	93	56	35	59	77	87	31	47	17	37	58	32	66	54	34	75	57	9	49	85	21

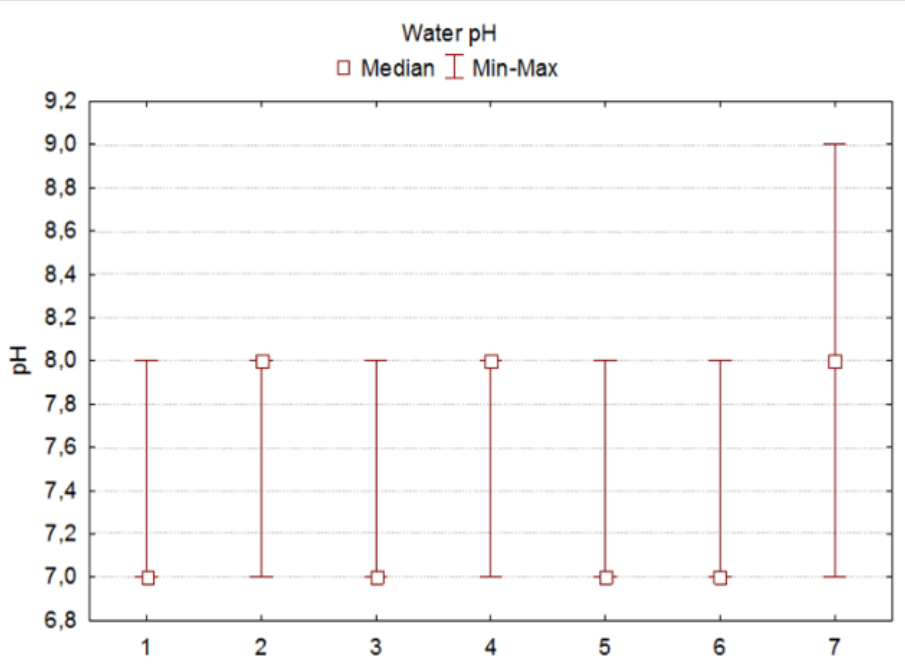
(*) Site 1 - 2017. On three stones are found 951 simuliidae. It is excluded to analyze the variability without this case.

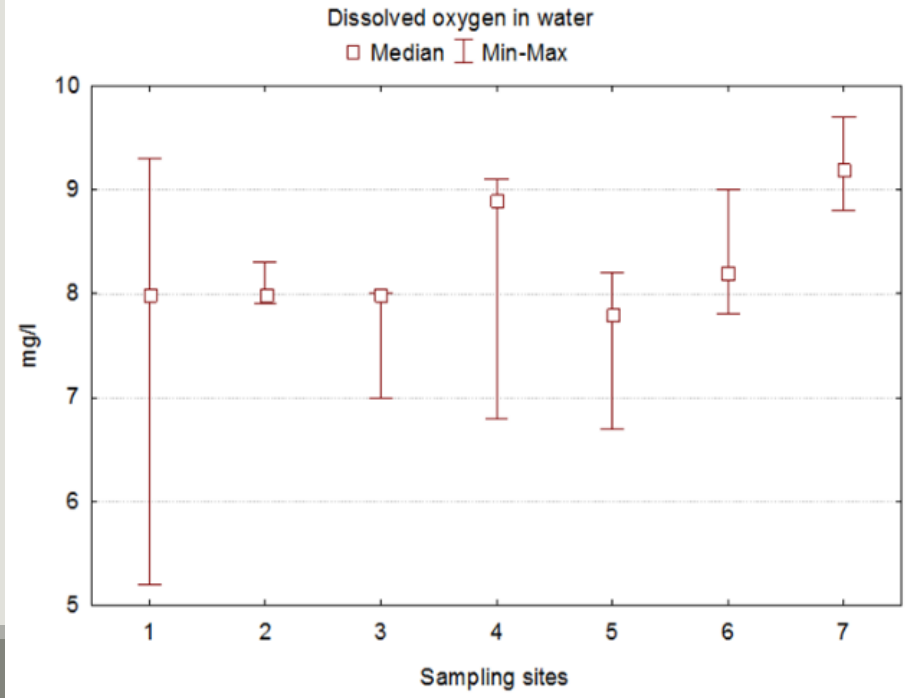
Results: Physical-chemical analysis

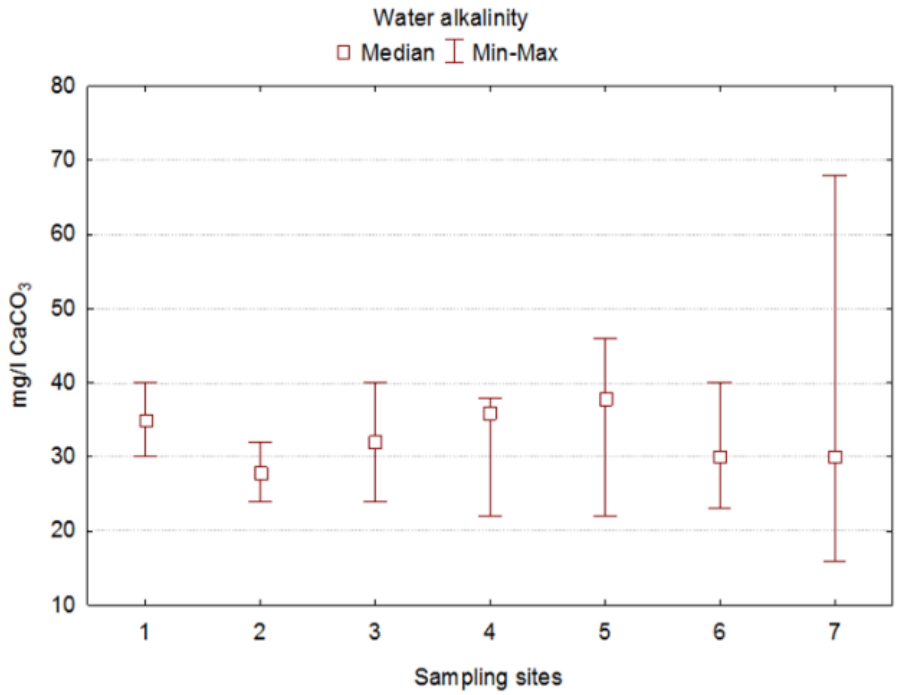


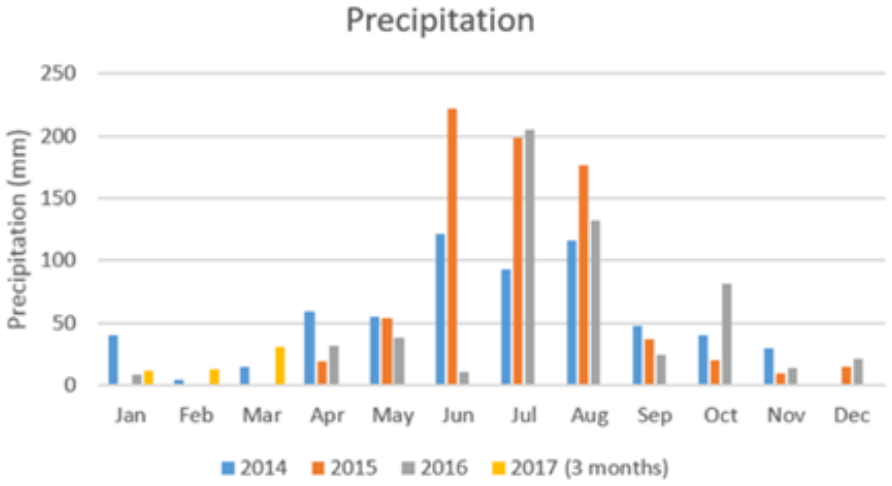


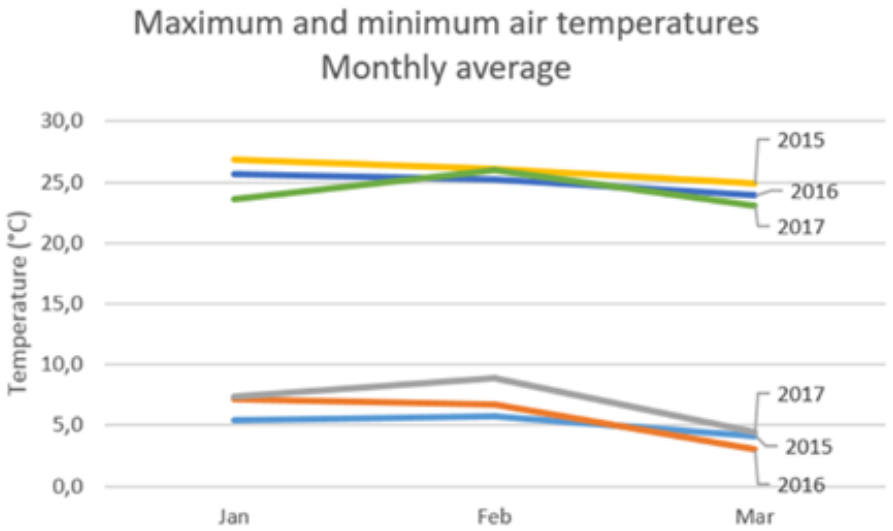

Water temperature
Median
Min-Max
Temperature (°C)
24
22
20
18
16
14
12
10
8
1
2
3
4
5
6
7

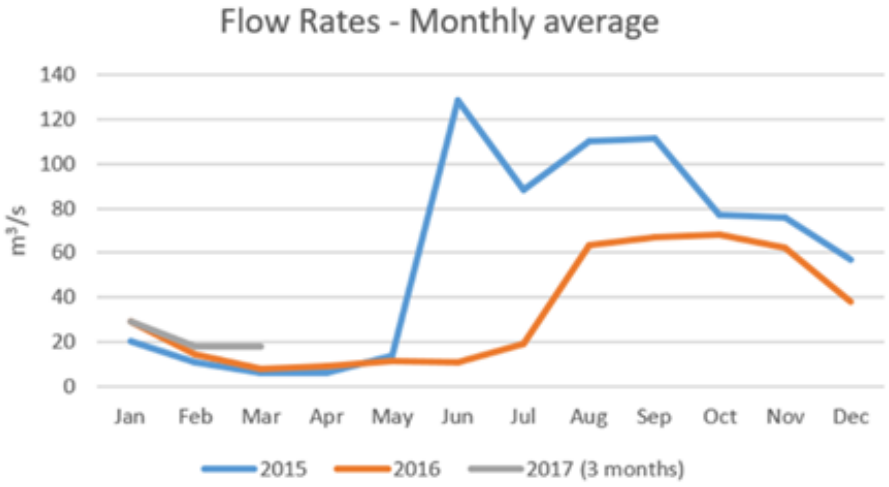

Water pH
Median
Min-Max
pH
9,2
9,0
8,8
8,6
8,4
8,2
8,0
7,8
7,6
7,4
7,2
7,0
6,8
1
2
3
4
5
6
7


Dissolved oxygen in water
Median
Min-Max
mg/l
10
9
8
7
6
5
1
2
3
4
5
6
7
Sampling sites


Water alkalinity
Median
Min-Max
mg/l CaCO3
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
Sampling sites



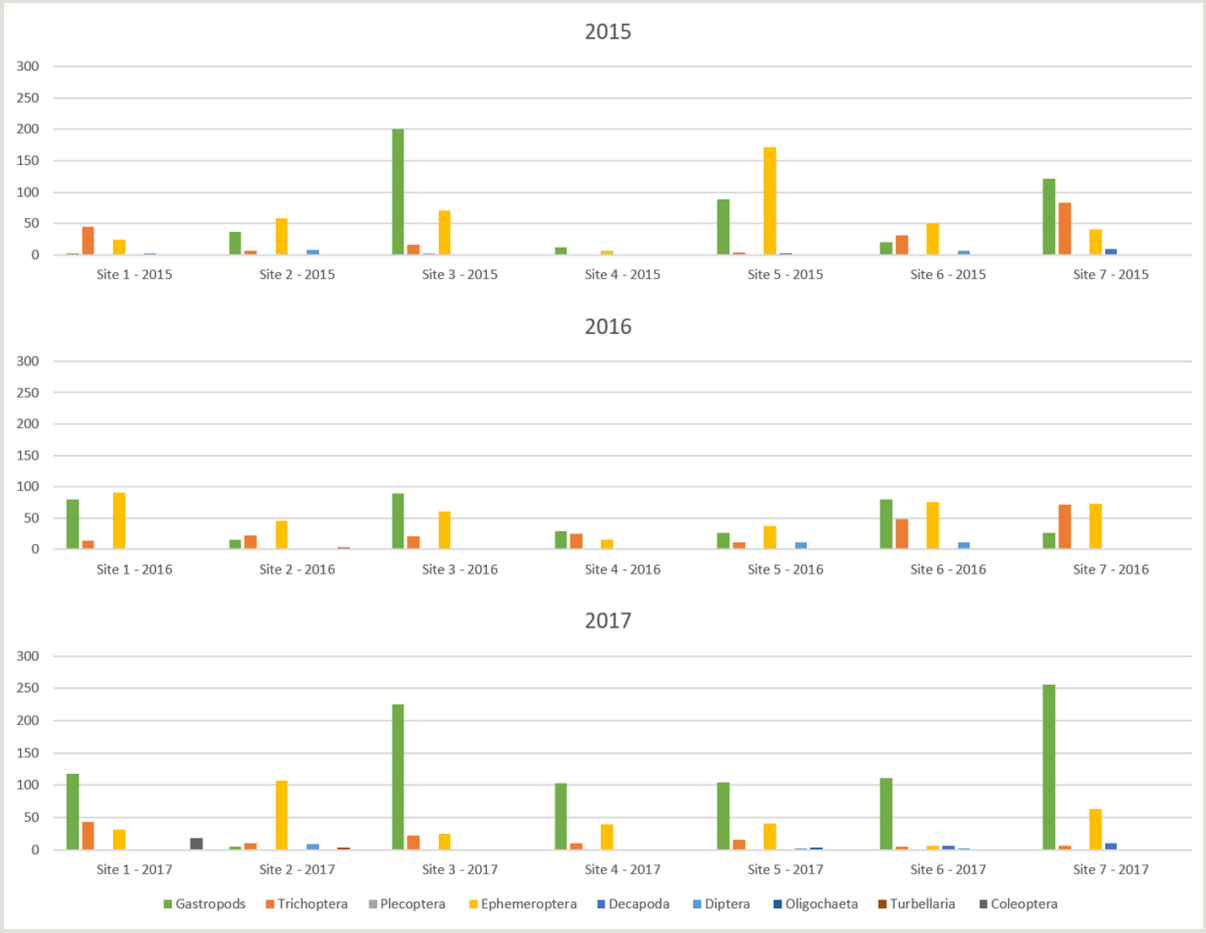


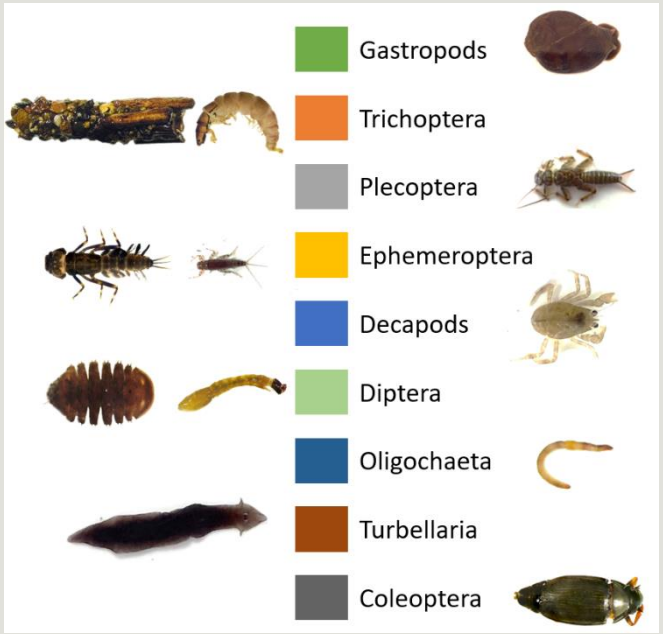


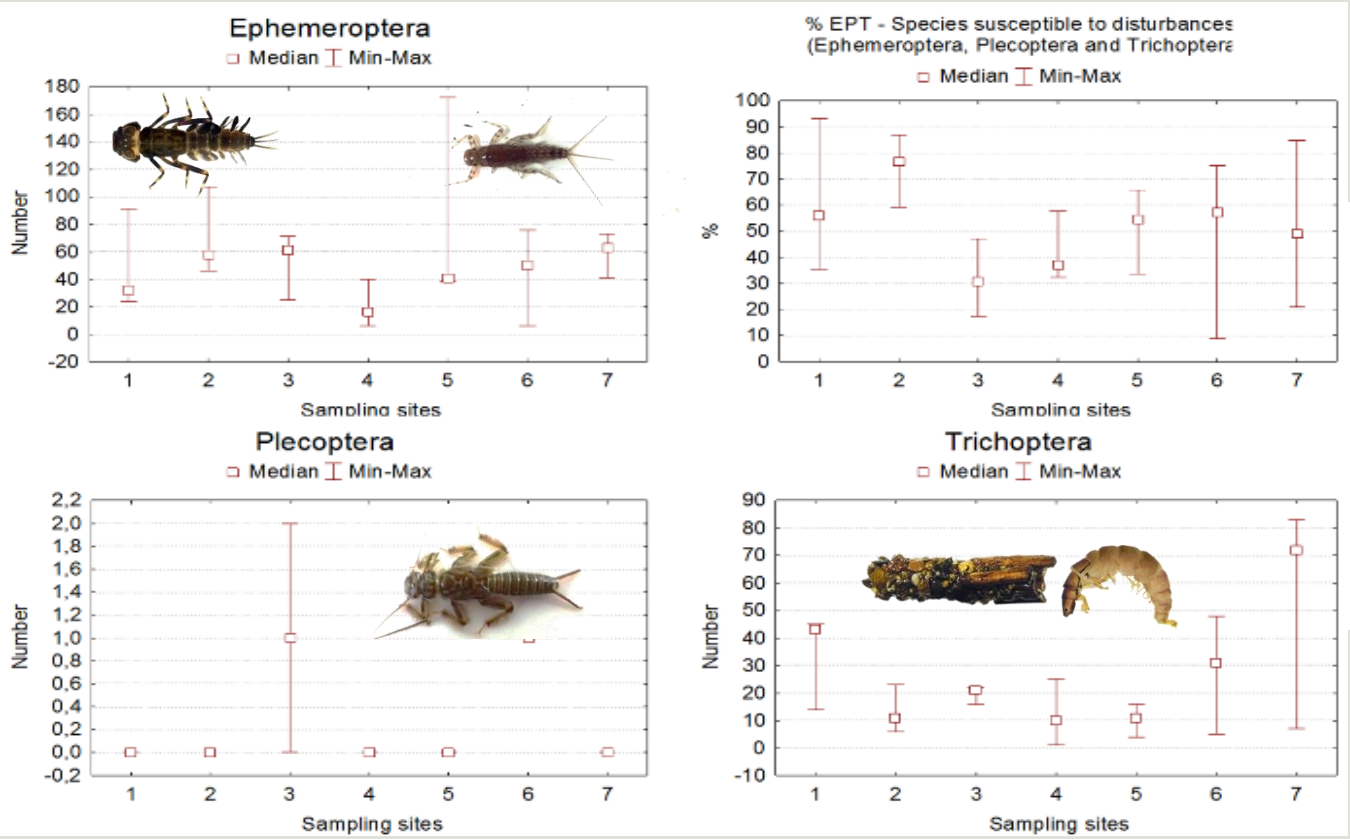
Source: Data provided by the AIC (Interjurisdictional Authority of the Limay, Neuquén and Negro river basins).

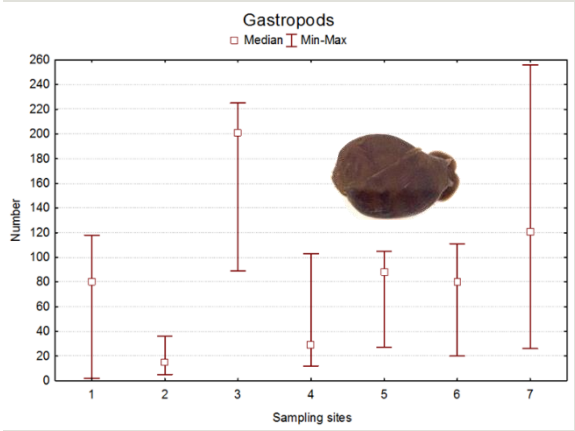
Data of the Casa de Lata site, located between sampling sites 2 and 3 of the present investigation.

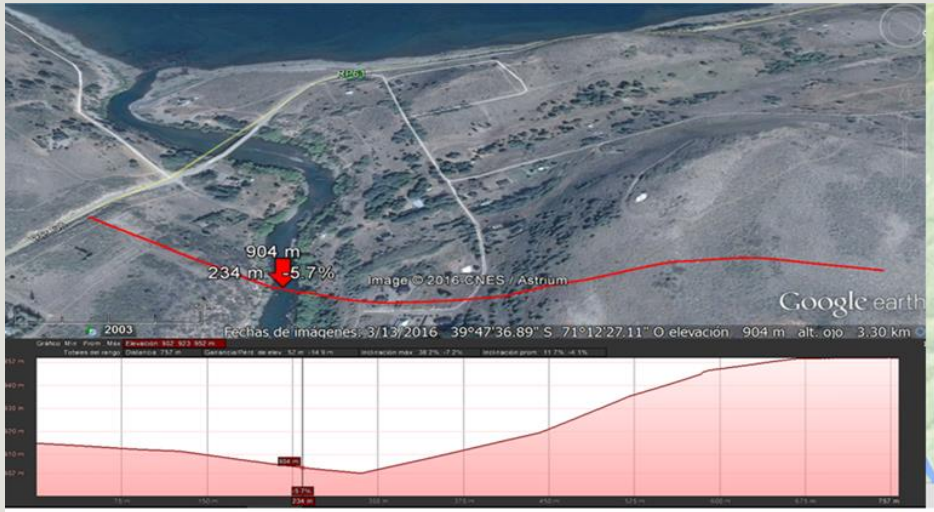
Results: Benthic macroinvertebrates

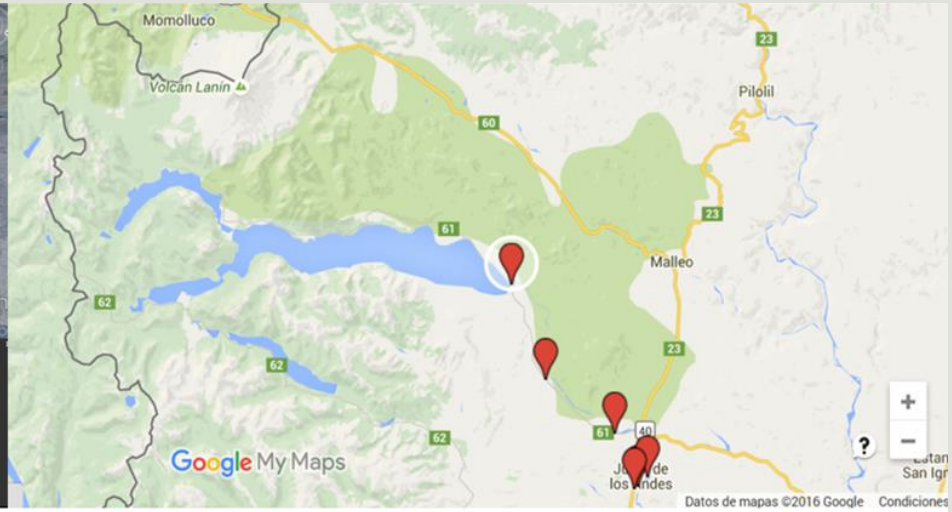





Ephemeroptera
Median Min-Max
Number
Sampling sites
% EPT - Species susceptible to disturbances
(Ephemeroptera, Plecoptera and Trichoptera
Median Min-Max
%
Sampling sites
Plecoptera
Median Min-Max
Number
Sampling sites
Trichoptera
Median Min-Max
Number
Sampling sites


Gastropods
Median Min-Max
Number
Sampling sites





Site 1
Headwaters of the
Chimehuín river
Rural zone

Site 1
Headwaters of the Chimehuín river

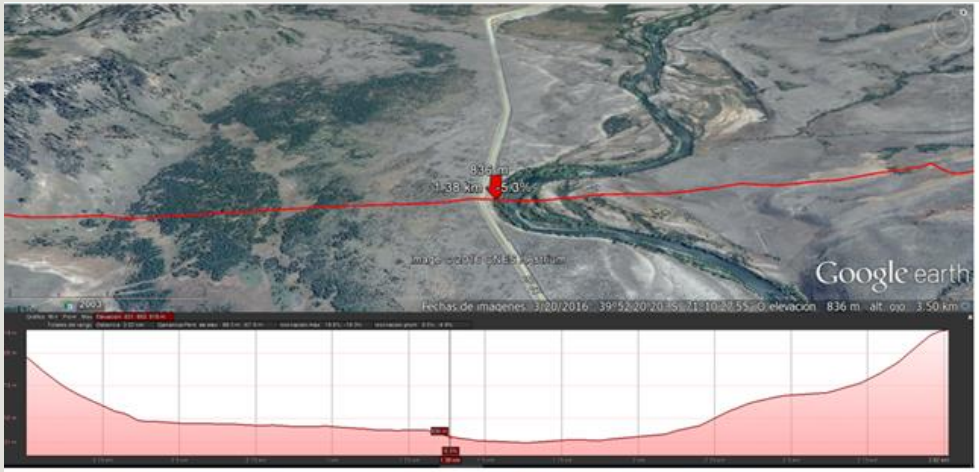
1. The total of macroinvertebrates was increasing in each evaluated year
2. It changed the composition of the dominant taxon (from trichoptera to Ephemeroptera and finally to gastropods).
3. The EPT percentage decreased. It is a site exposed to winds and sedimentation is observed. It is used for tourism and sport fishing.

Trichoptera
2015

Ephemeroptera
2016

Gastropods
2017

Place	Site 1 - 2015	Site 1 - 2016	Site 1 - 2017
Temperature	18	16	12
Dissolved oxygen	5,2	9,3	8
Turbidity	0	0	0
pH	8	7	7
Alkalinity	30	35	40
Nitrates	< 0,2	< 0,2	< 0,2
Gastropods	2	80	118
Trichoptera	45	14	43
Plecoptera		0	0
Ephemeroptera	24	91	32
Decapoda	0	2	0
Diptera	3	0	0 (*)
Oligochaeta	0	0	1
Turbellaria	0	0	0
Coleoptera	0	0	18
Total macroinvertebrates	74	187	212
Dominant taxon	Trichoptera	Ephemeroptera	Gastropods
Number dominant taxon	45	91	118
% Dominant Taxon	61	49	56
Total EPT	69	105	75
% EPT	93	56	35



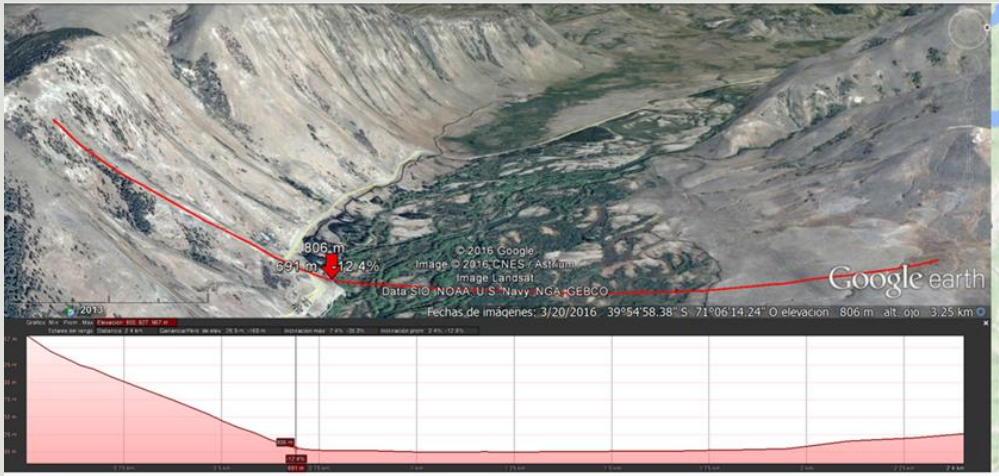
Site 2
Horseshoe
Rural zone

Site 2 - Horseshoe

1. The total of macroinvertebrates remains relatively stable.
2. The dominant species (Ephemeroptera) remained and the percentage of EPT was slightly higher.
3. It is a place visited by sport fishermen. It is an area with very good riverbank, wooded and repaired from the winds.

Ephemeroptera
2015 – 2016 – 2017

Place	Site 2 - 2015	Site 2 - 2016	Site 2 - 2017
Temperature	19	12	12
Dissolved oxygen	8	7,9	8,3
Turbidity	0	0	0
pH	7	8	8
Alkalinity	28	32	24
Nitrates	< 0,2	< 0,2	< 0,2
Gastropods	36	15	5
Trichoptera	6	23	11
Plecoptera	0	0	0
Ephemeroptera	58	46	107
Decapoda	0	2	0
Diptera	8	1	9
Oligochaeta	0	0	0
Turbellaria	0	3	4
Coleoptera	0	0	0
Total macroinvertebrates	108	90	136
Dominant taxon	Ephemeroptera	Ephemeroptera	Ephemeroptera
Number dominant taxon	58	46	107
% Dominant Taxon	54	51	79
Total EPT	64	69	118
% EPT	59	77	87



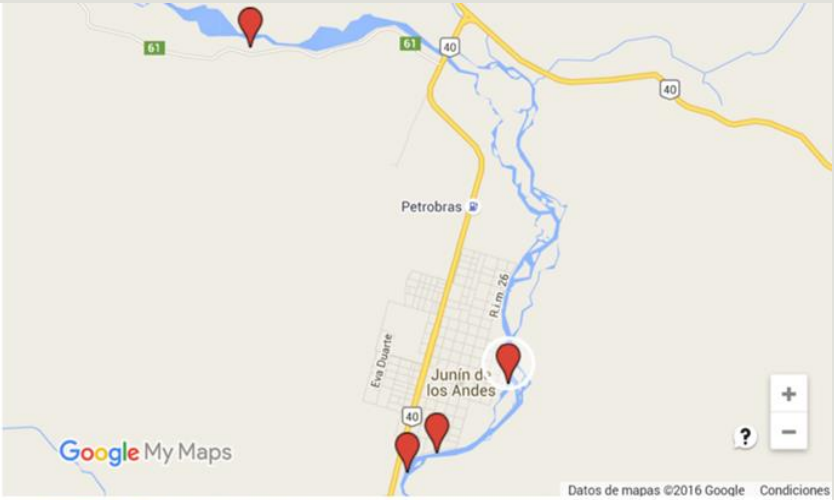
Site 3
Camping Santa Lucia
Rural zone

Site 3 - Camping Santa Lucia

1. The total number of macroinvertebrates decreased in 2016 and then recovered in 2017
2. The dominant species (gastropods) rose and the percentage of EPT continues to drop.
3. It is a camping site, very visited in summer. It has a nearby gravel road where soil movements were carried out during 2016 for the construction of a route. This has caused an abundant sedimentation in the river.

Gastropods
2015 – 2016 – 2017

Place	Site 3 - 2015	Site 3 - 2016	Site 3 - 2017
Temperature	12	12	10
Dissolved oxygen	8	7	8
Turbidity	0	0	0
pH	7	8	7
Alkalinity	40	32	24
Nitrates	< 0,2	< 0,2	< 0,2
Gastropods	201	89	225
Trichoptera	16	21	22
Plecoptera	2	0	0
Ephemeroptera	71	61	25
Decapoda	0	1	0
Diptera	0	0	0
Oligochaeta	0	1	0
Turbellaria	0	1	0
Coleoptera	0	0	0
Total macroinvertebrates	290	174	272
Dominant taxon	Gastropods	Gastropods	Gastropods
Number dominant taxon	201	89	225
% Dominant Taxon	69	51	83
Total EPT	89	82	47
% EPT	31	47	17



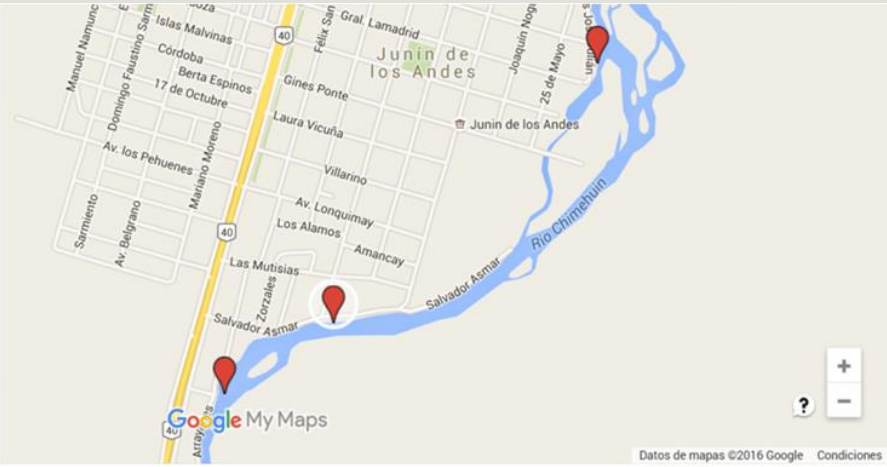
Site 4
Costanera
Urban zone

Site 4 - Costanera

1. In 2015, the new waterfront was built and soil movements were made very close to the river.
2. In 2016 and 2017 an increase in the total of macroinvertebrates is observed, the dominant species (gastropods) is maintained, the EPT% remains low.
3. It is the most visited place of the river during the summer.

Gastropods
2015 – 2016 – 2017

Place	Site 4 - 2015	Site 4 - 2016	Site 4 - 2017
Temperature	14	12	12
Dissolved oxygen	8,9	9,1	6,8
Turbidity	0	0	0
pH	8	8	7
Alkalinity	36	38	22
Nitrates	< 0,2	< 0,2	< 0,2
Gastropods	12	29	103
Trichoptera	1	25	10
Plecoptera	0	0	0
Ephemeroptera	6	16	40
Decapoda	0	1	0
Diptera	0	0	1
Oligochaeta	0	0	0
Turbellaria	0	0	0
Coleoptera	0	0	0
Total macroinvertebrates	19	71	154
Dominant taxon	Gastro pods	Gastro pods	Gastro pods
Number dominant taxon	12	29	103
% Dominant Taxon	63	41	67
Total EPT	7	41	50
% EPT	37	58	32



Site 5
San Martín Street and the river
Urban zone

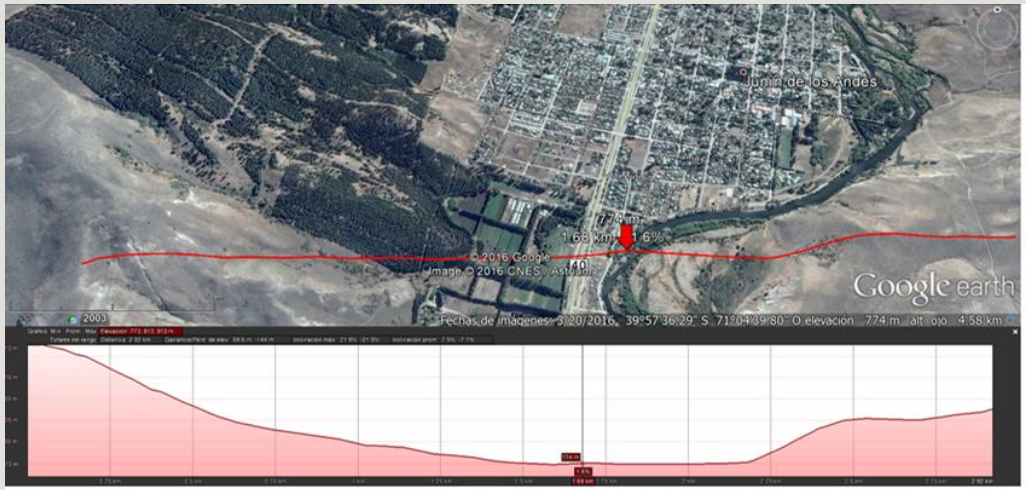
Site 5 - San Martín Street and the river

1. In 2016, the total number of macroinvertebrates decreases. The riverbank is almost nonexistent, has a nearby street, buildings have been made.
   - There are vacant lots that nobody removed the volcanic ash when the cleaning took place in the city of Junín de los Andes. It is likely that the runoff has reached a large part of the river.
2. It is an area visited by bathers.
3. In 2017 the number of macroinvetebrates increases but the dominant species changes to gastropods and the percentage of EPT continues to decrease.

Ephemeroptera
2015 – 2016

Gastropods
2017

Place	Site 5 - 2015	Site 5 - 2016	Site 5 - 2017
Temperature	21	12	18
Dissolved oxygen	7,8	8,2	6,7
Turbidity	0	0	0
pH	8	7	7
Alkalinity	46	38	22
Nitrates	< 0,2	< 0,2	< 0,2
Gastropods	88	27	105
Trichoptera	4	11	16
Plecoptera	0	0	0
Ephemeroptera	172	38	41
Decapoda	3	1	0
Diptera	1	12	2
Oligochaeta	0	1	4
Turbellaria	0	0	0
Coleoptera	0	0	1
Total macroinvertebrates	268	90	169
Dominant taxon	Epheme roptera	Epheme roptera	Gastro pods
Number dominant taxon	172	38	105
% Dominant Taxon	64	42	62
Total EPT	176	49	57
% EPT	66	54	34



Site 6
South of the Municipal Quincho
Urban zone

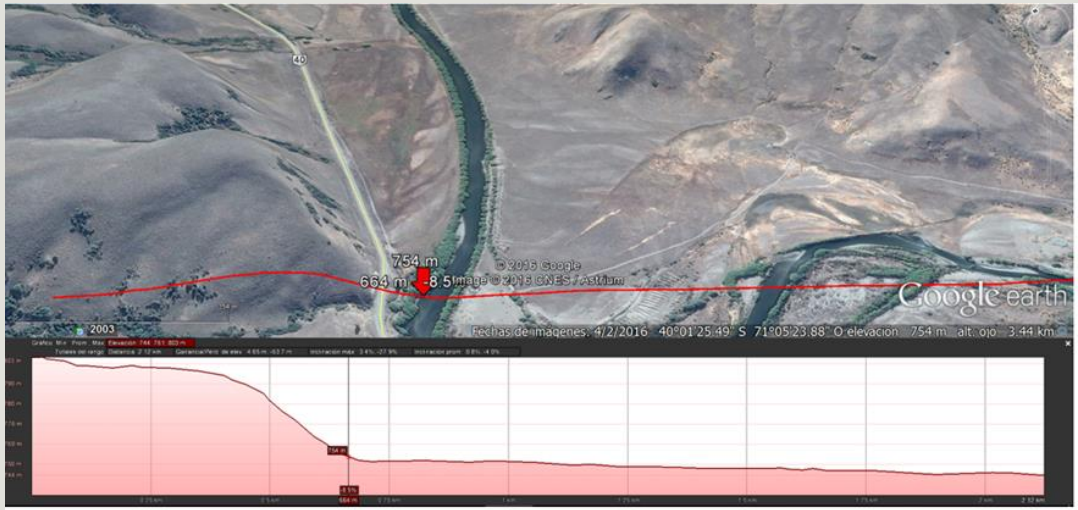
Site 6 - South of the Municipal Quincho

1. An increase in the total of macroinvertebrates is detected but the dominant species changes (from ephemeroptera to gastropods), the percentage of EPT also decreases.
2. It is an area visited by bathers.
3. It is exposed to the winds and part of a small cliff was detached, widening the river. Increased sedimentation.

Ephemeroptera 2015

Gastropods 2016 – 2017

Place	Site 6 - 2015	Site 6 - 2016	Site 6 - 2017
Temperature	16	10	16
Dissolved oxygen	9	8,2	7,8
Turbidity	0	0	0
pH	7	8	7
Alkalinity	30	40	23
Nitrates	< 0,2	< 0,2	< 0,2
Gastropods	20	80	111
Trichoptera	31	48	5
Plecoptera	0	0	1
Ephemeroptera	50	76	6
Decapoda	0	0	7
Diptera	7	12	2
Oligochaeta	0	0	0
Turbellaria	0	0	0
Coleoptera	0	0	1
Total macroinvertebrates	108	216	133
Dominant taxon	Ephemeroptera	Gastropods	Gastropods
Number dominant taxon	50	80	111
% Dominant Taxon	46	37	83
Total EPT	81	124	12
% EPT	75	57	9



Site 7
Curve of the Saints
Rural zone

Site 7 - Curve of the Saints

1. Changes the dominant species (gastropods to Ephemeroptera and then to gastropods).
2. The percentage of EPT increased in 2016 but decreased again in 2017. This area is visited by fishermen and bathers.
3. It is located under the sewer drain (6.5 km from the riverbed).
4. Junín de los Andes is a tourist city, in some summers the population is tripled and this affects the flow of sewers that reaches the river (the disturbance is variable according to the number of tourists).

Gastropods 2015

Ephemeroptera 2016

Gastropods 2017

Place	Site 7 - 2015	Site 7 - 2016	Site 7 - 2017
Temperature	22	12	12
Dissolved oxygen	9,7	9,2	8,8
Turbidity	0	0	0
pH	9	8	7
Alkalinity	30	68	16
Nitrates	< 0,2	< 0,2	< 0,2
Gastropods	121	26	256
Trichoptera	83	72	7
Plecoptera	0	0	0
Ephemeroptera	41	73	63
Decapoda	9	0	10
Diptera	0	0	0
Oligochaeta	0	0	0
Turbellaria	0	0	0
Coleoptera	0	0	0
Total macroinvertebrates	254	171	336
Dominant taxon	Gastropods	Ephemeroptera	Gastropods
Number dominant taxon	121	73	256
% Dominant Taxon	48	43	76
Total EPT	124	145	70
% EPT	49	85	21

Discussion

The physical-chemical parameters of water quality remained relatively stable between the samplings of the summers 2015, 2016 and 2017

The populations of macroinvertebrates showed changes, the main differences were registered in the following sites:

Greatest impact

Site 3

Site 4

Site 7

Site 1

Site 5

Site 6

Site 2

Less impact

Conclusions

1. The data indicate that the volcanic eruption has had an impact on macroinvertebrate populations. The greatest impacts occurred:
   - In sites with soil movements:
     - Construction of the waterfront in 2015 (site 4)
     - Soil movement on provincial route 61 (site 3)
   - In urban sites or in places visited by tourists.
2. This would indicate that the **impact is not totally attributable to the volcanic ash**, it is also added the anthropic impact and the effect of the runoff after a rain and the winds that redistribute the ash again.

Conclusions

3. The fall of ashes and the use of the soil around the river contributed **more sedimentation** causing changes in the populations of macroinvertebrates.
4. This work was limited to sampling sites in public areas, so other sites with less anthropic impact could not be verified to attribute the effects to the volcanic eruption.
5. It is necessary to continue with measurements in the following years to evaluate the capacity of recovery of the impacted areas.